The true Effigies of Nathaniell Nye, Mathematician.

W. Hollar delin: et fecit Aqua fortis
Londini 1644

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THE ART OF GUNNERY.

Wherein is deſcribed the true way to make all ſorts of Gunpowder, Gun-match, the Art of ſhooting in great and ſmall Ordnance: Excellent ways to take Heights, Depths, Diſtances, acceſſible, or inacceſſible, either ſingle or divers diſtances at one operation: to draw the Map or Plot of any City, Town, Caſtle, or other fortified place. To make divers ſorts of Artificiall Fire-works, both for War and Recreation; alſo to cure all ſuch wounds that are curable, which may chance to happen by Gunpowder or Fire-works.

This Treatiſe is compoſed for the help of all ſuch *Gunners and others, that have charge of Artillery*, and are not well verſed in *Arithmetick* and *Geometry*: all the rules and directions in this Book, being framed both with and without the help of *Arithmetick*.

By *Nathanael Nye* Mathematician, Maſter-Gunner of the City of *Worceſter*.

LONDON,
Printed for *William Leak*, at the ſign of the Crown in *Fleetſtreet*, between the two Temple Gates. 1670.

To the Right Honourable
the EARL of

LINDSEY,

Lord great CHAMBERLAIN
of ENGLAND.

Right Honourable,

THE Patronage of Arts being hereditary to your noble Ancestors, especially that of Warre, wherein so

many of the famous *Britans* have been tranſcendently glorious, encouraged theſe few ſheets of mine to crave the protection of your Lordſhips favour againſt the malicious ignorance of this unhappy age. The addreſſes, I do humbly acknowledg ſavour of too much boldneſs: the Treatiſe ſhort: and the Authour not of years Confident to preſent Pieces worthy of your Lordſhips favour, or peruſall. Yet the matter in it ſelf being Noble and ſuitable to theſe times, and the well known propenſity in your Lord-

Lordships nature, to cherish ingenuous endeavors with the particular service I ever did owe and bear to your Lordship and Noble Family, occasioned these bold addresses

Of your Lordships,

my LORD,

most humble Servant,

N. NYE.

To the Reader.

LOving Friend, the cause moved me to set Pen to paper to write such a Treatise as this Book of Gunnery, was because that in all the Books of this Art yet Printed, I never saw one that gave ample directions to attain to any knowledge without the Art of Arithmetick; I do also verily believe that when a man hath learned that Art in whole Numbers and Fractions, as also to extract

tract the Square and Cube Roots; that he will be without any of their directions, able to do that which divers of them imploy half their Books to teach; in this my Treatise I have added divers Tables for thy help, to resolve those things which are elswhere taught to be resolved by Arithmetick: *and if thou hast knowledg in that excellent Art, here are things worth thy observation; I am sure divers of them were never published before: and whatsoever thou findest in my* Fire-works, *I do protest to thee, that I have made, and still do make practice of them my self;*

ba-

having by experience found them the best of all others that ever I *have read of, or that are taught by* Bate, Babington, Norton, Tartaglia, *or* Malthus; *if any man shall make the least doubt of what* I *have said,* I *am ready to resolve him: And to conclude, according as thou findest the truth of what* I *have written, so give thy doom,* I *rest*

Thy Loving Friend,

Nathanael Nye.

Arts Mathematicall (in *Worcester*) Profeſſed by *Math. Nye* Mathematician, theſe Arts, Sciences, and Faculties here under expreſſed.

- **Arithmetick**
  - In whole Numbers and Fractions.
  - Exraction of Roots
    - Square,
    - Cube,
    - Of Aſtronomicall Fractions.
- **Geometry**
  - The Principles, with the practice and Demonſtration.
  - Meaſuring of Land and reducing of Plots or Maps, to any Proportion;
  - Meaſuring of any ſuperficiall or ſolid content, as Board, Glaſſe, Timber & Stone,
  - Gaging of Veſſels the exacteſt way.
- **Deſcription, Demonſtration, and uſe of Inſtruments,**
  - Quadrant, Theodelite, Plain Table,
  - Circumferenter, Circular Scale,
  - Mathematicall Scale or Sector,
  - Rules by Maſter *Gunter*, converted into a Croſſe-ſtaff.
- **Aſtronomy**
  - The uſe and demonſtration of the Sphear or Globe, both Cœleſtiall and Terreſtriall,
  - The Cœleſtiall Globe in Plain.
  - **Navigation**
    - The Principles thereof, with the making of divers Inſtruments befitting that Art.
    - The uſe and Projection of Maps and Charts.
    - To find the true longitude at Sea.
  - To calculate the true motion of the heavens, and to find the eclipſes for any time, either paſt, preſent, or to come.
  - To make Dials of all ſorts, either fixed, or Inſtrumentall.

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Of

Of Artificiall Fire-works for Recreation and Delight.

The ART of GUNNERY, AND First of Gunpowder.

CHAP. I.

Who were the first Inventors of Gunpowder, and how it came to be invented.

SOme *Italians* have declared, That *Archimedes* the Philosopher was the first Inventor of Guns and Gunpowder; for *Valturus* declareth in the tenth Book of Warfare, That *Archimedes* used a certain kind of Engine made of Iron, out of which he shot against an Army upon the land (with an incredible noise) stones of great weight and bigness; which Relation makes us believe, That it was an Engine like unto a Gun; But whether this be true, or not, is doubted, for learned men are of

divers minds: *Munſter* and *Gilbert Cognot* have written, That Guns were deviſed firſt in the year of our Lord 1370 by a Monk, whom *Munſter* called *Bertholdus Sthwarts*: Mr. *Dee* our Countrey man, in his Mathematical Preface and Diſcourſe of Menadre, ſaith, That an Engliſh-man was the firſt Inventor of Gunpowder, though his ſaid invention in another land, and by other men, was firſt executed: Alſo our Engliſh *Chronicles* do report, That in the year 1380, a Monk did unwillingly let fall a ſpark of fire upon Brimſtone and Saltpeter, beaten to powder, in a Mortar, covered with a flat ſtone; he ſeeing this mixture blow off the ſtone from the Mortar, did thereupon deviſe a kind of powder, and taught the *Venetians* to uſe the ſame in Iron pipes againſt the *Genuates*.

CHAP.

CHAP. 2.

What ſorts of Powder they made (from time to time) from the firſt Invention, to this preſent.

POwder was always made of Saltpeter, Brimſtone and Charcole; although ſome Authors have counſelled to adde to the ſaid materials, Quickſilver, to make it more ſtrong: others adviſe us to uſe Aqua-vitæ; ſome would have us adde thereto ſome Armoniack; ſome bid us put thereunto Camphir; ſome make Gunpowder with the coals of Bulruſhes, and divers other wayes, which I will not ſet down: But I will here ſhew you the making of Gunpowder from time to time, as it was collected from ſuch Authors as lived either one or two hundred years ſince: by which you may gather, how that Gunpowder hath ſtill mended, and grown to great perfection ſince the firſt invention.

The making of Gunpowder after the mo ancient manner, *Anno* 1380.

The first way,

Saltpeter	one part
Brimstone	one part
Charcal	one part

The making of Gunpowder, as Author teach, about the year 1410.

The Second way,

Saltpeter	three parts
Brimstone	two parts
Charcoal	two parts

The making of Gunpowder, as it wa made in the year 1480.

The Third way.

Saltpeter	eight parts
Brimstone	three parts
Charcoal	three parts

The making of the best Powder abou the year 1520.

The Fourth way.

Saltpeter	four parts.
Charcoal	one part.
Brimstone	one part.

The best sort as is made now at this pre-
sent

The fifth way,

Saltpeter	six parts.
Brimstone	one part.
Charcoal	one part.

The Musket powder is now commonly made of Saltpeter five parts, one part of Brimstone, and one of Coal; and Cannon powder of Saltpeter four times so much as of Brimstone and as of Coal.

CHAP. 3.

The reason why Powder made of six pounds of Saltpeter, one pound of Brimstone and one of Charcoal, is stronger than Powder made of seven pounds of Saltpeter, one of Brimstone, and one of Coal; and also stronger than Powder made of five pounds of Peter, one of Sulphur or Brimstone, and one of Coal: Or else why six of Peter, one of Sulphur, and one of Coal, is the strongest Powder that can be made.

IT is certain, that the best powder would be that in which is most Saltpeter, if a

ſmaller quantity of Sulphur and Coal, then but once ſo much of either of them, as to be one ſixth part to the quantity of peter, might ſerve; which compoſition I will call 6—1—1, meaning ſix times ſo much peter, as one time Sulphur, and one time Coal. But leſs Sulphur and Coal, as 7—1—1, the Sulphur and Coal are not able to perform and execute the office as they ought to do, that is to ſay, to be on fire quickly, and ſet the Saltpeter on fire, and to maintain the ſame fire, untill it be wholly reſolved into fire; therefore no more Sulphur and Coal to ſo much peter, would be to little purpoſe: Certainly if Gunpowder were only made of peter, that would be more ſtrong than powder made of peter, Coal and Brimſtone; but becauſe the ſaid peter is not apt to burn in a flame quickly, as Brimſtone will do, nor maintain the flame until all is conſumed, as Coal will do, therefore it is needfull to adde Sulphur and Coal thereunto, and onely ſuch a quantity as will juſt ſerve turn: In powder 5—1—1, by experience is found more Sulphur and Coal than needeth; yet it is good not only to make powder of 5—1—1, which is

Musket

Musket Powder, but also of 4—1—1, which serveth best for great Ordnance. Now the reason why this last sort should serve better for Ordnance, than Pistol powder of 6—1—1, which is the strongest of all, I will shew in the next Chapter.

CHAP. 4.

The reason why Pistol Powder being the strongest, is not so good for the Cannon as Powder 4—1—1, the weakest; no not although you take but so much of the Pistol Powder as you find by an Engine to be of like strength with another quantity of Cannon Powder.

THe reason why Cannon Powder is best for Ordnance, is because it taketh up a greater room in the Cylinder of the piece, than pistol powder, for in taking up much room, it hath the greater fortification of Metall about it, to keep it from breaking the piece: Suppose a Saker requireth four pound of great powder for her loading, and I would know how much pistol powder is equal in strength to four pound of Cannon

Cannon powder, trying by an Engine made of purpose to try powder, I find three pound to be of like force: you may easily conceive that the three pound hath but three quarters of the Metall of the Piece, to keep it from breaking, when as four pound hath one quarter more Metall then the other three had.

To make it more plain, if you look into the second Chapter you shall find, That the first powder of all was made of just so much Saltpeter, as of Coal, and of Sulphur, called 1—1—1; if you had such powder, and also one of the old Pieces made in those days, as some of them may yet be seen in many Cities of *England*, you could not load them with any other powder but they would break. You shall hear what I have done; I made such kind of powder as 1—1—1, and tryed how much of that powder was in strength to one pound of Pistol powder, being 6—1—1, by an Engine I found three pounds and nine ounces, the piece was Saker bore of Iron, and the thickness of the Metall about the Chamber was two inches in thickness; I loaded the piece with four pound of

weak

weak powder, which filled the Cylinder of the bore nine inches just; which nine inches in length, and two in thickness about the Chamber, is Two hundred twenty five inches of Metall about the powder, near Forty seven pound weight, at this adventure the Piece came off safe; but being loaden with one pound and a quarter of fine powder almost, which filled the bore but two inches and three quarters, and had to its fortification but Sixty eight inches and three quarters, which is in weight fifteen pounds, at the discharge of the Gun, it brake in divers pieces; This was done in *Deriton*, upon the 17 of *March*, *Anno Dom.* 1644. as many people can witness.

CHAP. 5.

How to make Artificial Saltpeter of the Earth.

SAltpeter is a mixture of many substances gotten with fire and water, out of dry and dirty earth, or out of that ground which is found loose within Vaults, Tombs,

Tombs, or desolate Caves, where rain can not come in; and also Charnel houses. The best of all is made of beasts dung converted into earth, in Stables, or in Dunghils, of a long time not used; and it is requisite, what dung soever it be that by long continuance of time it be well resolved into earth, and all the moistness dryed up: When you have occasion to make of this dung, or earth, a great quantity of Salpeter, it will be necessary for you to provide many Cauldrons; Furnaces, Barrels and Tubs, and wood for fire; these Barrels must be set on end upon a Form, the top being taken out, and near the bottom a hole bored with an Augre, you must cover the inside of those holes with an earthen Porringer, and stop the outside with Taps; then fill up the Barrel with the said earth within a span of the brim, and remember that the earth about the said vessels should be rammed down, yet that part of the earth that lieth in the midst of the vessel, may lie loose; afterwards pour a Bucket of clean water upon the earth, and after that pour another, not failing to do so till all the earth within the

Tub

Tub be well moistened, which ought to continue thus one day and night, the water a full handsbredth above the earth, then pull out the Taps or Spiggots out of the holes in the vessel, and let the water drop out of that vessel into another, being set under it: When you see no more water will drop, empty the undermost vessel again into the uppermost, out of which it did drop; and out of the same let it drop again, so long and so much as it can; this water when it hath dropped twice, is called water of Foot, and also the wash of earth, and must be saved by it self. After this pour other clean water upon the very same mould in the Tub, and when the said water hath dropped out of the higher vessel into the Tub that stands under, take all the earth out of the upper vessel, and fill it with more of the said earth, then pour upon this earth in the vessel the water as you made first, called water of Foot, and wash of earth, suffering it to drop through the same into the undermost Tub, standing under the earth Tub, so often until it be so salt as to bite your tongue, and that an egg will swim on the top of the water. The

first

first water being brought to this perfection, pour the second water upon the said earth or other earth, that it may by often passing through be of as biting a taste as the former, as also able to bear up an egge: Now this second water being very strong, must be boiled in a Cauldron, and after it hath well boiled, abate the fire under the Cauldron, untill you have taken off it all the scum, which must be saved in a Pot; then presently make a good fire, to cause it to boil again with speed; and as the water in the Cauldron diminisheth, scum the said water, and keep the said scum: When the scum shall be thick, hard, and of a French Russet colour, take some water out of the Cauldron, and let it drop upon a piece of Iron, for if the water be boiled enough, the drops of water will congeal upon the same Iron, but if they do not congeal, it is a sign it may abide the fire longer; when its boiled, as you may perceive by the aforenamed signs, take it from the fire, and preserve it, because it is the Peter-water: Now when you have made an end of boiling the second water, you must boil and scum the first water (named water of Foot, or wash

of

of earth) till it ſhall caſt up a ſcum of a French Ruſſet colour, unto which if it ſhould happen to cleave to the ſides of the Cauldron, you may put in the other Ruſſet ſcum (that was made and ſaved by you before) to boil with it, untill the drops of this water falling upon Iron will congeal; if this congealed water be very ſoft, you muſt boil it longer, but if hard, it is a ſign it is burned; to amend this fault, put ſome clear water thereunto to amend it, then taking the Cauldron from off the fire, and ſetting it aſtoop, ſo that the lees and dregs (which being congealed are the very ſalt whereof Saltpeter is made) may not with any water run over the brims of the veſſel: You muſt (if you will make good Peter) ſuffer the ſaid water to ſettle in the ſame veſſel, and congeal in a dankiſh room, and the water which after two or three dayes will not congeal, hath dropped into ſome other Tub, take the Salpeter out and preſerve the water that dropped, becauſe it is Maſter water, and ſhall afterwards be uſed as I ſhall give you directions.

CHAP.

CHAP. 6.

To make another excellent sort of Saltpeter of Flower that groweth on walls: How Saltpeter water must be boiled, and how you may know when it is boiled enough.

TAke of flower or plaster that groweth on walls four parts, of unslact lime one part, this one part of lime must be well boiled in water over a fire, and after it hath boiled enough, it must be taken from the fire, and suffered to settle, then it must be strained into another vessel; then put the four parts of flower into such a vessel as I in the last Chapter ordered for earth; pour upon the said flower so much of the strained water, which I call lee or lime water, as will dissolve the flower; when the flower is dissolved, let the water drop out of the said vessel, into an under vessel; then boil those said drops of lime water over the fire, till they being put upon Iron will congeal, and be of a temperate hardness; for if they are very hard, the water is burned, but if soft, not enough; when it is well boiled (that is, to have the drops thereof

on

Iron neither too hard nor too soft) take it from the fire, and scum it with a scummer, and do unto it all that hath been taught, in the last chapter, to be done with peter-water.

CHAP. 7.

To make a third sort of Saltpeter very excellent; and with more ease, and less cost than the two former ways

TAke Quicklime, and pour warm water upon it, and let it stand six days, stirring it once or twice a day: take the clear of this water, set it in the Sun until it be wasted, and the Saltpeter will remain in the bottom.

CHAP. 8.

How to refine Saltpeter, to make it fit for use.

PUt Saltpeter with well slacked lime into a clean Cauldron; and pour upon it so much lime-water, or fair water, as will lie

lie four fingers in height above the Pe
and lime, and make a good fire under th
Cauldron, that they may quickly boil
and be you ready, as ſcum ſhall riſe, to tak
it away with a ſcummer; when you per
ceive that no more ſcum will riſe, take th
Kettle from the fire, and ſetting it ſome
what aſlope, let the boiled water cool, ſet
tle, and clear in the Sun; if the boiled wa
ter will not wax clean by this means, pu
aſhes into it, and boil the ſame again a litt
while. This done, take the Cauldron a
gain from the fire, and ſet it aſlope, ſprin
kle on the boiled water ſome fair wate
cold, for by ſo doing you ſhall make th
ſaid water clear; this water being clear
muſt by little and little be poured out int
ſome other veſſel, ſo that the dregs n
grounds may not go out with the ſame;
for the water which lieth above in the
veſſel Saltpeter is made, and in the water
below at the bottom of the veſſel, which
are the lees or dregs of Saltpeter; after you
have in this ſort poured out the ſaid water
into other veſſels, and have ſuffered the
ſame for two dayes (or more if need be) to
congeal in the ſame veſſels, you muſt take

the

he ſaid congealed water (which is Salt-
eter) out of the veſſels, and dry the ſame
ith the heat of the Sun, or by the fire.

After you have taken the ſaid Saltpeter
ut of the veſſels, let the water which re-
ains boil over a good fire, and when it
aſts up any ſcum, take the ſcum off, then
y whether it be enough, by dropping
ome on Iron; if it congeal in a temperate
ay, take it from the fire; this being done,
s it cooleth you ſhall ſee a thin skin to
e upon the water, which alſo ſcum off;
his water will then congeal into Peter, as
id the other, but it is not ſo good.

To refine Saltpeter with fire, do thus;
ake an Iron Skillet and fill it with Peter,
et it on the fire, and cover it cloſe with
ome Iron cover on the top, or with a
yle; when the Saltpeter is melted, take
rimſtone moſt finely beaten, and caſt
ome thereon, kindle it, and let it burn till
ll the upper part be burned; which when
ffected, will leave the Saltpeter clear like
o a piece of Marble, for the Brimſtone
ill burn up the groſs viſcouſneſs of the
altpeter.

CHAP. 9.

How Saltpeter meal is made; and how Pet meal, without any beating, will serve make Gunpowder with his materia

HAng a Kettle over the fire, and put Sal peter therein; when it shall begin boil, fry and smoke, stir it about with wooden Ladle, cease not to mingle Saltpeter well together, untill it wax dr for by so doing you shall take away grease and salt that was in it; then pour so much water into the Kettle as will co the Peter, you must melt the Peter ag over the fire, continually stirring it, unt it become dry as before, and be like me

CHAP. 10.

How the makers of Gunpowder do mingle gether the materials of which they make Gunpowder: And also how to c the Powder.

PUt all the Saltpeter together that y will use into a Cauldron, for if it be mak

make Cannon powder, you must take four parts Peter, one part Brimstone, and one part cole; if Musket powder 5 — 1 — 1; if Pistol powder 6 — 1 — 1; boil the Salt-peter in a Cauldron, with so much water as will serve to dissolve it; which being so dissolved, ought to be washed and laid upon a clean place; this done, beat into dust the quantity of Cole that is to be added to this mixture, and then put this dust or fine beaten Cole unto the dissolved Peter, incorporate them very well together, and as you are blending them, put in by little and little the Sulphur very well beaten; when this mixture of Salt-peter, Brimstone and Cole, are well incorporated, lay it forth to dry a little; when the same mixture is somewhat dryed, by beating the Cole untill it is subtile and impalpable, and is made a very well mixed substance, sift it well through a sieve; then casting water or vineger upon it, corn it, and when you have so done, dry it against the fire, and Gunpowder is made. There are divers wayes to grinde Gunpowder; the best way is to stamp it in Morters, with a Horse-mill or Water-mill, for the powder is thereby

moſt finely beaten, and with leaſt labor; with a knife cut in pieces ſome of this compoſition, and if it appear all black it is well done, but if any of the Brimſtone or Peter is ſeen, it is not incorporated enough: Now I will ſhew you how to corn Gunpowder.

Firſt, prepare a ſieve, with a bottom of thick parchment, made full of round holes, then moiſten the powder, which ſhall be corned, with water, put the ſame and alſo a little bowl into the ſieve; when you have ſo done, ſift the powder, ſo as the bowl rowling up and down in the ſieve may break the clods of powder, and make it by running through the little holes, to corn.

You may alſo make Gunpowder by ſifting every one of the three materials by it ſelf through a very fine ſieve, and then moiſten them with ſtrong vinegar, and incorporate them together, for through that moiſtneſs the powder will be made more ſtronger, and beaten more finer, then corn it as before is taught: Note, That if you cannot ſift it through the ſieve, beat that again into powder which will not through,

untill

untill it will go through alſo; when you have ſifted theſe materials two or three times ſeverally, then blend them well together, and ſift them alſo together; when you have done this, then moiſten them with vinegar, and proceed as before: Remember alſo, That Charcole made of the lighteſt wood is beſt

CHAP. II.

To make Powder of divers colours; and firſt, to make White Powder.

TAke of Saltpeter twelve parts, of Brimſtone two parts, and of Camphir one part, beat, ſift and incorporate all theſe things together, as before you have been taught to mix other materials together; after you have ſo done, beat theſe things ſo again, and ſo oft, untill you are ſure they are well incorporated, then moiſten it with Aquavitæ; when you have thus done, corn the powder.

To make Red Powder.

Take of Saltpeter twelve parts, of Brimstone two parts, and of Camphir one part, beat, sift and incorporate all these things together, as I taught just now; then beat them again untill they are perfectly incorporated: whereas before you moistned them with good Aquavitæ, now you must moisten this with Vineger (sod with a good quantity of Brasil, untill the third part be boiled away) this Vineger being red as blood, will make the powder likewise so, it being moistned with it, and then corned as before is taught.

To make any other coloured powder.

Boil the Vineger in such transparent colours as you would have the powder to be of; as if green, with a little Verdigreace, if blew, with blew Bice, and the like; alwayes taking care, That the colour be not thick, but very thin, otherwise it will weaken the powder that you do make.

CHAP.

CHAP. 12.

To renew and make good again any sort of Gunpowder that hath lost its strength by moisture, long lying, or by any other means.

HAving moistened the said Gunpowder with Vineger, or fair water, beat it well in a Mortar, and then sift it through a sieve or fine searce; with every pound of Gunpowder mingle one ounce of Saltpeter that hath been mealed; and when you have so done, beat and moisten this mixture again, untill you see by breaking or cutting with a knife, that there is no sign of Saltpeter or Brimstone in it: Moreover, corn this powder when it is incorporated with the Peter as it ought to be, and you have done.

CHAP. 13.

Another way to renew Gunpowder, or rather to unmake Gunpowder, to make it good, by the making it again.

PUt ſo much thereof (as you will refine or new make again) into a linen bag and then tie a ſtring or rather ſmall cord about the mouth of the ſaid bag, then put it into a clean Kettle, and pour ſo much water therein as will cover the bag; this done, make the water to boil, till a drop of it laid upon iron or ſtone will congeal; and while the water boileth remember to ſcum it, if need require; when it will congeal, take it from the fire, and ſet the Kettle aſlope; when the water is as clear as it will be, pour it out into ſome veſſel where it will congeal into Saltpeter; when you have taken the Saltpeter out of the ſaid veſſel, that water that remains boil again, untill it will (by dropping a drop thereof upon iron) congeal; then put it again into the ſame veſſel; and thus do with all ſuch water as is laſt after you have taken out the Peter.

Th

The Saltpeter and Brimstone which were within the said bag did dissolve and soke into the boiling water; yea, the dissolved Peter turned into water, and the Brimstone sunk down to the bottom of the water, where you may find it; but the Coles (which were formerly compounded with the Peter and Brimstone) they remain in the bag, amongst the lees and dregs of the decayed Gunpowder: therefore when you have gathered together all the Saltpeter by the means above named, and dryed the same, weigh it, and also weigh the Brimstone and Cole by themselves, and what you find every thing to want in its quality and due proportion, make up with more; then mingle, beat and incorporate them, as you have been taught, to make new Gunpowder.

CHAP.

CHAP. 14.

How you may by taste, feeling, colour and burning, know good and ill Powder; and how amongst many sorts of Gunpowder you may know the best sort.

1. BY how much Gunpowder is the harder in feeling, by so much the better it is.

2. Gunpowder of a fair Azure or French Russet colour, is very good, and it may be judged to have all its receipts well wrought, and sufficient of the Peter well refined.

3. Lay two or three corns of Gunpowder upon a white piece of paper, the one three fingers distant from the other, and put fire to one of them, if the powder be good and strong, you shall see them all on fire at once, and that there will remain no grosness of Brimstone or of Saltpeter, no not any thing but a white smoky colour in the place where they were burned, neither will the paper be touched.

4. If good Gunpowder be laid upon the palm of your hand, and set on fire

re, you will not be burned.

5. Gunpowder that hath a very ſharp ſtre, hath abundance of the Peter not well ſined, and will moiſten again.

6. If white knots, or knots of a french aſſet colour, ſhall remain after powder is red, it is a ſign that the Saltpeter was not ell refined, but left full of ſalt, and greaſe; ſpecially when the ſame knots ſhall in urning be dankiſh, and leave moiſture n the place where the Gunpowder was urned.

7. If hard, dry and white knots, or pearls, hall remain after the Gunpowder is ſet on ire, it is a ſign that the Gunpowder is not well wrought, and it becometh every Gunner to beware of ſuch powder, becauſe if it doth lie long in a Piece, it will wax ſo fine, that if you unload not the Piece, it will in his diſcharge indanger the Piece of breaking.

8. If ſmall black knots, (which will burn downwards in the place where proof is made) remain after firing, they do ſhew that the Gunpowder hath not enough of the Peter, and that it is of little force or ſtrength, and ſlow in firing.

9. If a little heap of Gunpowder set fire doth make a noise, rise up with great speed, and yield little smoke, it is a sign of very good powder.

10. If the flame of fired Gunpowder shall rise up slowly, continue long, make little noise, and yield smoke in great abundance, it is a sign the powder hath much Cole and Brimstone, and too little Peter.

11. If Gunpowder burned upon a board shall black the same, it is a sign that there is overmuch Cole in that powder.

12. When Gunpowder is moist, or full of the earth of Saltpeter, it is naught to be shot out of great Ordnance, for it shameth the Gunner which useth it.

13. If Gunpowder be very black; it is either a sign that there is too much Cole, or that it is moist, and when you rub it upon white paper, it will black it more than other good Gunpowder will do.

14. Amongst many sorts of powder to know the best, make a little heap of every sort, and then setting those heaps one from another; mark well when you put fire unto them, which of the heaps did soonest take fire; for that powder which will soonest be

fire, ſmoke leaſt, and leave leaſt ſign hind it, is the beſt ſort of Gunpowder.

CHAP. 15.

ow to make excellent good match to give fire to any Ordnance, &c.

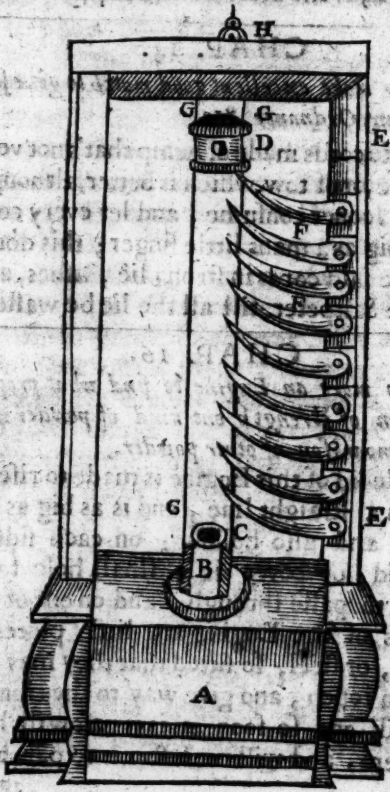
TAke cords made of hemp that's not very fine, or of tow, which is better, although will ſooner conſume, and let every cord ſo big as a mans little finger; this done, oil the ſaid cords in ſtrong lie, aſhes, and little Saltpeter, till all the lie be waſted.

CHAP. 16.

low to make an Engine to find what proportion of ſtrength one kind of powder is in compariſon of other powder.

THe lid of this Engine is made to riſe up in a ſtraight line, and is as big as the box, and alſo hollow; on each ſide of the lid or cover is a ſmall hole for a wyre to paſſe through, and on one of the pillars of the Engine are little pieces of braſs, or ſteel, ſo fitted that they may riſe with a touch, and give way to the riſing of the lid, and ſo ſoon as it is paſt will hold it there, and will not ſuffer it to paſs back again;

again; the form whereof is here presented



The

A The foot whereon the Engine ſtandeth.

B The powder box, which hath two ſmall wires paſſing from each ſide to the top, to keep ſteddy the lid in its motion.

D The lid which hath alſo two holes on each ſide for the wyres to paſs through.

E The ſide of the Engine, which is divided, on which is placed, at every diviſion, one of thoſe Pieces to ſlide up and catch the lid.

F F The form of theſe catches, being either of ſteel or braſs.

G G The two wyres that guide the box lid, and muſt be put into a little piece of braſs, at the top, which may be ſcrewed higher or lower at pleaſure, for the better ſtraightning of the ſame.

H The ſcrew which ſtreightneth thoſe wyres, placed on the top.

The uſe of this Engine.

Take about one dram of ſuch a ſort of powder as you eſteem to be the beſt of all others, and put it into the box, after it is covered with the lid, at the touch-hole, which is in the bottom of the box, fire it with a red

red hot wyre, being first primed with powder dust, then observe how high and to what division it ascends, which being noted down, take just so much powder of a courser sort, and try that in like manner as you did the former; then by noting up to what degree it ascendeth to, you may perceive the just difference between your best and worst powder; and by the same order, of any other sort, as you shall desire to know its strength, and have occasion to use.

But in the next Chapter, I shall describe some other wayes, because every man cannot come by a good instrument to try the just strength of any powder.

CHAP. 17.

How to try the strength of powder some other wayes than is before rehearsed.

IF you charge a Pistol, and discharge it against a bank of clay; do this with a little powder alwayes observing to take the like quantity to a grain of one sort of powder, as you do another sort: Then by measuring

measuring how far the bullet pierced in the clay, you may have some guess at the strength: also if you can make Rackets, such as fly into the air, and are made of Powder-dust, and Charcole-dust, by the strength or weakness of these you may know the like of powder.

If you can get a little Mortar-Piece (what a Mortar-Piece is you may read anon) cast at the iron furnace where the iron is made, to get one made in such a place is no difficult thing: Let it be made about three inches Diamet. at the mouth, and let the Chamber of the said Piece be three quarters of an inch Diamet: and two inches and one third part of an inch deep; load the Chamber with about half an ounce of powder, but put no wad in after it, the reason is, because one wad may be bigger than another, which will cause error; then put into your Mortar a Bullet of Lead or Iron that will just fit the bore: now if it be of Iron, it will weigh three pound and ten ounces, if of Lead, almost five pound: This Mortar-Piece being erected at a certain and unvariable elevation, and then being discharged, shall (by its several ranges)

tell the exact difference of powder abo
any other Instrument that can be invente
for by noting how many paces a shot ru
geth, you shall find the true differenc
and be able to set down the true and infa
lible proportion betwixt all sorts of pow
der whatsoever.

Because you may fail in procuring o
made at the Furnace where Iron is made
will shew you in the following Treati
how you may make such a one which m
serve your turn.

Thus having in the foregoing Treati
set down by whom, at what time, of wh
strength and violence Gunpowder was
when invented, also how to make any so
of Gunpowder, and lastly to try its strengt
I shall hence-following set down suc
Rules, that an ingenious man may learn
be a perfect Gunner, for I have omitte
nothing that is necessary in that Art.

CHAP

CHAP. 18.

Hence-forward shall be taught the Art of Gunnery: And first, what hath been the cause why this science is not of the like esteem as such a noble Art deserveth, and who are the causers and disesteemers of it.

THe true reason why this so famous an Art is at this present so slighted, is because divers men for lucre of gains and good pay, have made friends, or some of them are friends and kinsmen to such as have authority to place and displace Gunners; and when such men as these should do service against the Enemy with their Guns, they bewray themselves what they are, which maketh some as ignorant Commanders (as they themselves are ignorant Gunners) to say, I could have made a better shot my self; I do not think but I could level a piece with the best Gunner in *England*, it is as easie to shoot in a great Gun as in a Musket; what need is there of maintaining any to be Gunners, considering we may have men at the twinkling of an eye to do as good service, and are as good

Gunners as these; such speeches are usual, when tidings of little or no service comes to the knowledge of such Committees and Governours (they never finde fault with themselves) that choose those Gunners, because divers of them are their friends and kinsmen, but lay all the blame on the Art, saying, It is unprofitable, it spends more powder then do's good service; scarce ever considering what a good Gunner may do: I appeal to any reasonable mans judgement, whether so good Musique can be expected from him who never touched Instrument, as from him which hath served and practised above seaven years in the profession? if an instrument be naught the Musick cannot be very good; likewise if a Gun be naught, it cannot work good effects: as in Musick, if any string be wanting it is defective; thus in Guns if materials be wanting, no reasonable man can expect the like service as when nothing is wanting, though it be at the hands of a good Gunner.

It is an evident thing, that if the shot hit such a mark (where execution may be done) that the effect will be according to every

ones

ones desire: It is also as evident, that the Art of Gunnery doth teach how, and with what Piece to hit any mark in its command: And it is also as evident, that such Gunners may be found which are perfect in the whole Art, therefore (I conclude) that it is most of all evident, that the fault is not in this Art, but in such Commanders, Committees and others, which the King or Parliament trusts in their Army or Garrisons to make choice of Gunners.

CHAP. 19.

The Properties, Office and Duty of a Gunner.

A Gunner ought to be skilful in Arithmetick and Geometry, to the end he may be able through his knowledge in those Arts, to measure heights, depths, bredths and length, and to draw the plot of any piece of ground, to make Mines, Countermines, Artificial Fireworks, Ramparts, Baskets of earth, and such like things which are used in the time of War, to be made for offensive or defensive service.

A Gunner that hath a charge, ought to have in readineſs all neceſſary things for his Artillery, theſe are Wheels, Axletree, Ladles, Rammers, Sheepskins to make Spunges, Gunpowder, Shot, Tampions, Chain-ſhot, Croſs-bar-ſhot, Canvas or ſtrong paper (to make Cartredges) Fire-works, artificial Torches, dark-Lanthorns, a gin to mount and diſmount Guns, Hand-ſpikes, Coyns, Budge-barrels to carry powder, and Baskets to carry ſhot to your Piece; he is alwayes, when leaſure will permit, to chooſe good Matchcords, to arm his Linſtock wherewith he muſt give fire.

A Gunner ſhould never be without a Ruler and Compaſſes to meaſure the Diameter or Bore of every Piece; and alſo the length of the Cylinder within, the better to fit her with a ſhot, and proportion a charge.

A Gunner ought to know the names, length, weight and fortification of every Piece about the Chamber (that is, ſo far as the Piece is loaden with powder) and be able to tell readily how much Gunpowder is a due charge for every Piece, what ſhot is fit, how many Matroſſes muſt attend the

ſame upon ſervice, how many Horſes or Oxen will draw the ſaid Piece, and in caſe they cannot be had, how many men will ſerve: And laſtly, he ſhould know how to charge and diſcharge Gunner like.

A Gunner ought not at any time to beat up the head of his powder barrels with an iron tool, but with a wooden mallet, which can never fire the ſame.

Every Gunner before he beginneth to ſhoot, ought to conſider, that a long wad of Hay, or of untwiſted Ropes, will make the ſhot to ſhoot wide of the mark.

Every Gunner before he beginneth to ſhoot, ought to conſider, whether the Trunnions be truly placed in the Carriage, whether the Carriage have a true length, whether one wheel be higher or reverſe faſter than the other, whether the platform whereon the Piece is to do ſervice, be level, or not; if not, to get the ſame amended: Laſtly, to make clean the platform; that no ſtone or other thing lie for the wheels to run upon, for all theſe things not well obſerved, will cauſe the Piece to erre.

Every Gunner before he loadeth his

Piece, must try whether it be true bored or no; if not, he is to proportion his charge accor ding to the thinneſt ſide of the metal, he muſt take his obſervation at the brich of the Piece, juſt over where he ſhall finde (by his art) where the middle of the bore wit hin the Piece is, by this means he ſhall make a good ſhot, out of a bad Piece.

Every Gunner before he makes his ſhot ought to conſider that if the Piece lye point-blank, or under metall, he ought to put in a ſufficient wad after the ſhot, to keep it cloſe to the powder; for if it ſhould not be cloſe, but ſome diſtance between, the Peece would break in the vacant place: but if in caſe you mount your Peece, then put no wad after the ſhot.

And one chief thing, in the laſt place, to know very well how to diſpart his Peece, be it either true bored, or not true bored, which he may try firſt.

CHAP.

CHAP. 35.

What qualifications every man ought to have, when he first gets or obtains (from such as are in authority) Commission to be a Gunner.

HE ought to have skill in the Arithmetick, to Adde, Substract, Multiply, Divide, to work any conclusion by the single or double Rule of Three; to abstract both the Square and Cube Roots, and to be perfect in the Art of Decimal Arithmetick: To touch these things I need not, being learnedly treated of by Mr. *Record*, Mr. *Johnson*, and best of all by *Jurdans* Arithmetick; all which Books are easie to be had, and at a cheap price: Whosoever hath not these qualifications, and no desire to learn them, he shall never be good Gunner: therefore I boldly affirm, That no honest man takes upon him this profession (but such as are thus learned) for it is not the duty of an honest man to undertake that (for the King or Parliaments service) which he is not able to perform.

When a fit man is entertained, the Master Gunner

Gunner whom he ſerves ſhould bring him to his Piece, and give him the denomination of every particular part, and other neceſſary things belonging to his Piece, which when he hath perfectly learned (which is the Baſe-Ring, the Trunnion-Ring, or Rings, the Trunnions, the Muſſel-Ring, the Handſpikes, the Coyns; and alſo deſcribed how far in the Bore is called the Chamber of his piece), he may, theſe things underſtood, proceed as followeth.

CHAP. 21.

How to make the true Diſpart of any (true bored) Piece of Ordnance.

GIrt the Piece round about the Baſe-Ring at the britch with a thrid, and alſo the Muſſel-King at the mouth; lay theſe two ſtrings upon a Table at length, and make two marks for the length of each ſtring; divide the diſtance between each of theſe two marks into twenty two equal parts, with your compaſſes, and ſeaven of them is the juſt Diameter; then meaſure with your compaſſes how many inches,

and

nd parts of an inch, each of theſe Diame-
ers are; ſubſtract the greater Diameter
ut of the leſſer, and take the juſt half of
he difference, and that is the true Diſpart,
inches and parts of an inch.

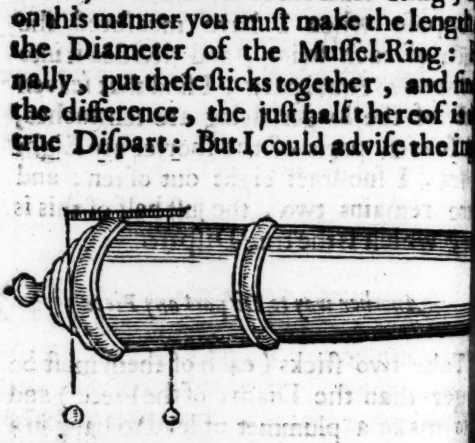
Example,

Suppoſe when I have meaſured the
ngth of each ſtring, and divided it into
wenty two equal parts, I find that ſeaven
arts of the longer ſtring are ten inches,
nd ſeaven parts of the ſhorter are Eight
nches, I ſubſtract eight out of ten, and
here remains two, the juſt half of this is
ne, which is the true Diſpart.

Another way to Diſpart any Piece

Take two ſticks (each of them muſt be
onger than the Diam: of the Piece) and
lſo make a plummet of lead to hang in a
mall thrid, put one of the ends of the
tick, which you ſhall lay acroſs the top of
he Baſe-Ring, to and fro, untill the plum-
net deſcending from the end thereof, may
uſt touch the ſide of the metall of the ſaid
Ring;

Ring; then keeping fast the stick in the place, hang your plummet by the other side of the stick, untill it just touch the metall of the Base-Ring on that side; when you have thus done, cut off the stick just at that place from whence the plummet descended perpendicularly; and this length is the just Diameter of the Base-Ring, and on this manner you must make the length of the Diameter of the Mussel-Ring: Lastly, put these sticks together, and find the difference, the just half thereof is the true Dispart: But I could advise the in-



genious Practitioner to try both wayes, and in case he finds any difference, to try again, otherwayes he may be deceived. For the better understanding of this

lusion, I have here fixed the demon-
ration.

A third way to Dispart a Piece of Ordnance.

If the Piece be not Chamber-bored,
ake the priming iron, and put it down in
he touch-hole, untill it stop at the metall
n the bottom of the bore, there make a
nark level with the Base-Ring, apply the
riming iron to the bottom of the metall
t the mouth, and so much higher as the
nark is (which you made at the Base-Ring)
hen the Mussel-Ring, so much is the true
Dispart.

CHAP. 34.

An observation to know whether your Piece be Chamber-bored.

FIrst, Dispart the Piece the two first
wayes, and when those two wayes agree
in one, take that for the true dispart; then
with your priming iron take the Dispart
this last way, which done, compare it
with the other Dispart first found, and
what

what it wants is the just difference of the Chamber from the Bore of the Piece. Suppose the Dispart truly found by the two first wayes be three inches, and by the last way to be but two inches, it shews that the Chamber differs from the true Bore each side one inch, so that if the Bore of the Piece be six inches high, the Chamber being one inch on each side lower, is but four inches high: This observation would alwayes have you to make, that you be not afterwards deceived, in making Cartredges of paper to load the same withall.

CHAP. 23.

To know what Diameter every shot must be to fit any Piece of Ordnance; or to choose shot for Ordnance.

DIvide the Bore of the Piece into Twenty equal parts, and one of these parts is sufficient vent for any Piece; the rest of the nineteen parts must be the height of the shot: But most Gunners now adays allow the shot to be just one quarter of an

inch lower than the Bore of the Piece; which rule makes the ſhot too big for a Cannon, and too little for a Faulcon; but if the mouth of the Piece be grown wider then the reſt of the cylinder within, by often ſhooting, to chooſe a ſhot for ſuch a Piece, you muſt try with ſeveral Rammer heads, untill you find the Diameter of the Bore in that place where the ſhot uſeth to lie in the Piece; and a ſhot of one Twentieth part lower than that place, is ſufficient.

Every Gunner ought to try his Piece, whether it be not wider in the mouth than the reſt of the Chaſe, and then proceed to chooſe his ſhot.

CHAP. 24.

To find what flaws, cracks and honycombs are in Pieces of Ordnance.

SO ſoon as you have diſcharged a Piece of Ordnance, cover the mouth of the Piece cloſe, and ſtop the touch-hole at that

that inſtant; by this you may know if any unknown cracks or flaws do go through the metal, for if they do, a viſible ſmoke will come through thoſe cracks and flaws.

Alſo it is a good way when the Sun ſhineth, to take a ſteel (or other) Looking glaſs, and with the ſame reflect the beams of the Sun into the mouth or hollow Cylinder of the Piece; for by this means a bright and clear light will be within, and by that ſplendid light you ſhall ſee every flaw, crack or honycomb.

But in caſe the Sun doth not ſhine, take a ſtick, ſomwhat longer than the Piece, having cloven one end of the ſaid ſtick for to hold an end of candle, put the ſaid ſtick, with the candle lighted, into the Piece; by this light obſerve, ſo well as you can, whether from the one end to the other, there be any of the aforeſaid in the Piece.

Alſo, if (in ſtriking a Piece of Artillery upon the outſide of the metall with a iron hammer) you ſhall at any ſtroke hear a hoarſe ſound, then without doubt there are honycombs, &c. but if you ſo ſtriking the Piece ſhall at every ſtroke hear a clear

ſound

ſound, aſſuredly the Piece is clear of any dangerous flaws, cracks, or honycombs.

CHAP. 25.

How to find the Diameter of any round ſhot, by the circumference.

YOu muſt gird the ſhot with a line, then divide that line into twenty two equal parts, and even of thoſe parts is the Diameter or height of the ſhot.

But the beſt way to avoid all miſtakes is to take the ſaid height or Diam: of the ſhot with a pair of Callapar compaſſes, as you may ſee by this demonſtration.

Alſo by ſuch a pair of Callapers you may find the Diameter of the Baſe-Ring, and of the Muſſel-Ring of any Piece of Ordnance; and by taking half the difference of thoſe two Diameters you may make the diſpart.

CHAP. 26.

How by knowing the height and weight of one bullet, to find the weight of another bullet, the height being given.

A Bullet of iron of ſix inches high, weigh- erh thirty pounds; what will the like bullet of ſeven inches in height weigh? Reſolution, firſt, Multiply ſix cubically, then multiply ſeven cubically; then as the cube of ſix is in proportion to the cube of ſeven, ſo thirty pounds (the weight of a ſhot of ſix inches high) is to ſo many pounds as a ſhot of ſeven inches high will weigh.

Examp-

Example.

First I multiply six cubically, there ariseth two hundred and sixteen, then I multiply seven cubically, which is three hundred forty nine; then I say, as two hundred and sixteen is to three hundred forty three, so thirty (the weight of six inches high) is to forty seven pounds, ten ounces, and one quarter; the weight of a shot seven inches high.

How to help those that cannot abstract the cube root (to resolve this proportion) two several wayes.

The first way is, to learn the use of a Table of cube roots, which I have annexed for the use and help of such as cannot extract the cube root; because my book should be as profitable an help as any Book ever hath yet been; for by this Table, you may learn to work almost any conclusion, as well as if you could extract the Root, and with more ease

An excellent Table to find the Cube roo
of any number not exceeding 1000000.

The root.	The cube.
1	1
1 1/4	1 95
1 1/2	3 37
1 3/4	5 36
2	8
2 1/4	11 39
2 1/2	15 62
2 3/4	20 80
3	27
3 1/4	34 33
3 1/2	42 32
3 3/4	52 73
4	64
4 1/4	76 77
4 1/2	91 12
4 3/4	107 17
5	125
5 1/4	144 90
5 1/2	167 37
5 3/4	190 11
6	216
6 1/4	244 14
6 1/2	274 62
6 3/4	307 55
7	343
7 1/4	381 08
7 1/2	121 87
7 3/4	465 48
8	512
8 1/4	561 51
8 1/2	614 12
8 3/4	669 92
9	727
9 1/4	791 45
9 1/2	857 37
9 3/4	926 89
10	1000
10 1/2	115 76
11	1331
11 1/2	1520 87
12	1728
12 1/2	1953 12
13	2197
13 1/2	2460 87
14	2744
14 1/2	30275 25
15	3375
15 1/2	3724
16	4096
16 1/2	4492
17	4913
17 1/2	5359
18	5832
18 1/2	6332
19	6859
19 1/2	7415
20	8000
20 1/2	8615
21	9261
21 1/2	9938
22	10648
22 1/2	11390
23	12167
23 1/2	12778
24	13024
44 1/2	14705
25	15625
25 1/2	16581
26	17576
26 1/2	18609
27	19683
27 1/2	20797
28	21972
28 1/2	23149
29	24389
29 1/2	25672
30	27000
30 1/2	28372

	the Cube		the Cube		the Cube
31	29792	58	195112	84	592604
32	32768	59	205379	85	614125
33	35937	60	216000	86	646056
34	39304	61	216981	87	648303
35	42125	62	238328	88	68 472
36	48656	63	250047	89	701669
37	50653	64	262344	90	729000
38	54872	65	274635	91	753571
39	55419	66	287496	92	778688
40	64000	67	300753	93	804357
41	68921	68	314432	94	830584
42	74088	69	329199	95	857375
43	79507	70	333000	96	884736
44	85184	71	357911	97	615673
45	91125	72	373348	98	941192
46	97336	73	389017	99	970299
47	103823	74	405224	100	1090000
48	110592	75	421875		
49	117649	76	438276		
50	125500	77	456533		
51	135651	78	474522		
52	140608	79	493039		
53	148877	80	312000		
54	157464	81	551441		
55	167375	82	550408		
56	175616	83	571787		

To work the last proposition by the Table.

First, In place of multiplying 6 cubically, find 6 in the Table, and right against it you shall have 216: which is the cube of 6; then find 7 likewise under the title Root, and under the title cube you shall find 343, the Cube of 7; then consider that so much as 216 is in proportion to 343, the like proportion 30 is to 47 pounds and ten ounces.

There is much about seven cube inches of iron in one pound; by this rule you may find 7 thirty times in 216 and 7; you may find seven to be contained in 343, just forty nine times; but this rule is not so perfect as the former, because in substracting seven out of 216, you shall find thirty pounds and $\frac{6}{7}$ parts, which is too much by the fraction.

CHAP.

CHAP. 27.

How by knowing the height and weight of one ſhot, to know the height of any other ſhot, the weight being given.

Suppoſe the height of the ſhot be three inches and three quarters, & the weight ſeven pounds five ounces; I would know what a ſhot of ſixteen pounds would be in height, according to the ſame proportion? Firſt, find the Cube root of three inches three quarters, which you may do by the Table; then as the ſeven pounds five ounces is to the Cube of $3\frac{3}{4}$, ſo ſixteen pounds is to ſuch a Cube whoſe root is the height of the ſhot ſought for.

Example.

By the Table I find the Cube of three inches three quarters to be 52 and 73 hundred parts of one unite (for all the fractions are ſo many parts of one unite, the ſaid unit being divided into 100 parts) then as ſeven pounds five ounces (the weight of a ſhot of inches $3\frac{3}{4}$ Diam:) is in proportion to $52\frac{73}{100}$ the Cube of inches $3\frac{3}{4}$ the height of the ſaid ſhot; ſo 16 (the weight of that ſhot whoſe height you ſeek) is to 115 the Cube,

whose root being found in the Table, is four inches three quarters, and somewhat more: for in the Table, the neareſt number beg to 115, is 107, the juſt Cube of four inches three quarters; and this number 115 exceeding the former by eight, this ſheweth that it is a very ſmall deal higher, ſcarce one half quarter of an inch: And you may alſo perceive by the laſt rule in the 26 Chapter, that ſeven inches cubical make a pound: now finding this to exceed 107 (the Cube of $\frac{3}{4}$) eight cubical inches, you may conclude, that it is one pound and one ſeventh part of a pound heavier than a ſhot of juſt four inches three quarters height.

CHAP. 28.

To find what proportion is between Bullets of iron, lead and ſtone; and by the knowing the weight of one ſhot of lead, to find the weight of any other ſhot of Iron, braſs or ſtone of the like Diameter.

THe proportion between lead and iron, is as two to three; ſo that a ſhot of three pounds

pounds of lead is of the like Diameter or height as two pounds of iron.

The proportion betwixt lead and brass, is as twenty four to nineteen

The proportion between lead and stone, is as four to one; so that one shot of lead of forty pounds, is of the height as a stone shot of ten pounds.

The proportion betwixt iron and brass, is as sixteen to eighteen.

The proportion betwixt iron and stone, is as three to eight; so that a shot of thirty pounds of stone, is as big as the like shot of eighty pounds iron.

The Reader taking these proportions into consideration, and having knowledge in the Art of Arithmetick, may with ease calculate (if iron shot be wanting, and the other to be had) what height and weight either shot of lead, brass or stone, ought to be of, to fit any piece of Ordnance: But for such as are not acquainted with Arithmetick, to calculate these proportions, for their help I framed a Table, that doth shew the weight of any shot of lead, iron and stone, from two inches Diameter, to eight inches, dividing every inch into quarters.

I do

I do confeſs that ſome ſort of ſtone is much heavier than other; but ſuch as you ought to uſe ſhould be that which is moſt compact, as Marble, Pibble ſtones alſo may be found which are round; and hard blew ſtone, ſuch as divers Tombs are made of, it being ſomewhat courſer than Marble; all theſe to my knowledge are much about that proportion as I have given: But ſuch as is ſoft, as Free-ſtone, and the like, they are not ſo pondrous as the other, nor ſo fit for uſe: Alſo lead, the finer and neareſt to tin, the leſs weight it is.

You are to note, That in loading your Piece with a ſhot of ſtone, you are not to load the Piece with ſo much powder as you did formerly with iron ſhot, but abate, according to the proportion as is between ſtone and iron.

CHAP.

CHAP. 29.

A Table to find the weight of one shot of Iron, Lead or Stone, from two to eight inches Diameter, exactly calculated.

Inches and parts of inch	Lead. poun.	ounc.	Iron. poun.	ounc.	Stone. poun.	ounc.
2	1	10 half.	1	1	0	7
2 one quart.	2	6	1	9	0	9
2 and a half.	3	3	2	2	0	12
2 three quar.	4	5	2	14	1	1
3	5	10	3	12	1	7
3 one quart.	7	2	4	12	1	13
3 and a half.	8	15	6	0	2	4
3 three quar.	11	0	7	5	2	12
4	13	7	8	15	3	6
4 one quart.	16	0	10	10 half.	4	0
4 and a half.	18	15	12	10 half.	4	12
4 three quar.	22	5	14	14	5	9
5	2	0	17	5	6	8
5 one quart.	30	2	20	1	7	8
5 and a half.	34	11	23	2	8	11
5 three quar.	39	9	26	6	0	14
6	45	0	39	0	11	4
6 one quart.	51	0	34	0	12	12
6 and a half.	57	0	38	0	14	4
6 three quar.	62	0	42	0	15	12
7	72	0	48	0	18	0
7 one quart.	79	8	53	0	20	0
7 and a half.	87	0	58	0	22	12
7 three quar.	96	0	64	0	24	0
8	106	8	71	0	26	10

You may, if you pleaſe, look into the former Table of Cube Roots, and compare this with that; for you ſhall find the Cube of each number bear the like proportion one towards another, as the weight of each Bullet is to another of the ſame metall.

Example.

The Cube of $3\frac{3}{4}$ is $52\frac{73}{}$.

The weight of a ſhot of three inches three quarters, is ſeven pounds five ounces.

The Cube of $4\frac{1}{4}$ is $107\frac{17}{}$.

The weight of iron ſhot of that height, fourteen pounds fourteen ounces; which is four ounces more then double ſeven pound five ounces, ſo likewiſe twice $52\frac{73}{}$ is $105\frac{46}{}$, which do's not exceed $107\frac{17}{}$ in being ſo doubled.

The uſe of this Table is very eaſie; but to make it more plain by this Example, I would know all the aforeſaid by three inches and three quarters Diam: I enter the Table under the Title inches, and parts of an inch, and right againſt it in the ſecond column, you ſhall find a ſhot of lead of that height to contain eleven pounds: In the next you ſhall find a ſhot of iron to weigh

weigh seven pounds five ounces; and in the last under the title Stone, two pounds twelve ounces, the weight of a stone shot of that height.

CHAP. 30.

How to make a shot of lead and stone (the stone being put in the mould in which the leaden shot should afterwards be cast) to be of the like Diameter and weight as an Iron shot is of.

I Have found by experience, That if you take five parts lead, and one part stone, it will come very near the matter, wanting not much above three ounces, which is nothing respecting the difference you shall find in Pibble stones: Here I have framed a Table of how much lead, and how much stone must be together, to make the equal weight of Iron shot, from one inch to eight every half inch.

A Table

A Table to find how much Stone must be put in the mould for Leaden Bullets to make them weigh like Iron Bullets of the same Diameter.

Inches.	Lead. poun.	ounc.	Stone poun.	ounc.	both together poun.	ounc.
1 inch.	0	1 2/3	0	0 1/3	0	2
1 and a half.	0	6 1/3	0	1 1/4	0	8
2 inches.	3	14	0	4	1	2
2 and a half.	1	12	0	8	2	4
3 inches.	3	2	0	10	3	12
3 and a half.	5	0	1	0	5	0
4 inches.	7	7	1	8	1	5
4 and a half.	10	8	2	2	12	10
5 inches.	14	7	2	14	17	5
5 and a half.	19	4	3	12	23	0
6 inches.	25	0	5	0	30	0
6 and a half.	32	0	6	0	38	0
7 inches.	40	0	8	0	48	0
7 and a half.	48	0	10	0	58	0
8 inches.	59	0	12	0	71	0

CHAP. 31.

How by knowing the weight of one Piece of Ordnance, to find the weight of any other Piece being of that very ſhape, of the ſame metall, or of any other metal, by the Table of Cube Roots.

IF the Piece be of the ſame metall that the piece whoſe weight you know of, you muſt do this, firſt take the greateſt thickneſs of your known Piece with your Callapers, and alſo of the Piece whoſe weight you know not; with their Diameters, enter the Table of Cube Roots; then obſerve, that as the Cube of the Diam: of the Piece (whoſe weight is known) is to the weight of the ſaid Piece, ſo the Cube of the Diam: of the Piece (whoſe weight you ſeek) is to the weight ſought for: But if the Piece be of another metall, firſt work as before, afterwards as the difference of the metall, iron and braſs, is between themſelves, ſo the weight found by the firſt rule is to the true weight ſought for.

Example

Example.

A brass' Saker of 1900 weight, hath its greatest thickness eleven inches and a half, whose Cube is 1520 $\frac{85}{}$ (as appeareth by the Table of Cube Roots). Now I find the Diam. of the other brass Piece, whose weight I know not, to be eight inches and three quarters, and by the Table I find the Cube to be 669 $\frac{92}{}$, then as 1520 $\frac{85}{}$, (the Cube of $11\frac{1}{4}$) is to 669 $\frac{92}{}$ (the Cube of $8\frac{3}{4}$) so 1900 (the weight of the known Piece) to 837 pounds almost; but if the Piece had been Iron whose weight you sought, then having done as much as before, first supposing as if it were brass, find the difference of the metals in Chap. 28. and the difference between Iron and brass will appear to be as 16 to 18, brass being the heavier; then say, as 18 (the weight of brass) is to 16 (the weight of a Piece of iron of the same bigness) so 837 (the weight of a brass Piece) is to 744, the weight of an iron Piece of the like shape and magnitude.

CHAP.

CHAP. 32.

How by knowing what quantity of powder will load one Peece of Ordnance, to know how much will load any other Peece.

THis Chapter or Propoſition is reſolved almoſt like the former: for firſt you muſt find the Cube Root of the diameter of the bore of that Peece, whoſe allowance of Powder for a charg you know: and alſo the Diameter of the bore of the Peece which you would know how much ſhould load, or charge it, then by the Table finde their Cubes, and as the cube of that you do know is to the cube of that you know not, to the quantity of powder known, is to that ſought for.

Example.

A Saker three inches three quarters diameter of the bore requires four pound;

what will a Demicannon of six inches and an half require? the cube of three and three quarters is 52 and 73 hundred parts of an unite, and the cube of six and an half is 274, and 62 hundred parts: Then say evermore, as 52. 73 (the cube of three and three quarters) is to 274, and 62 hundred parts, (the Cube of six inches and an half) so four pound of Powder to load a Saker, is in proportion 20 pound 13 ounces the Powder to load a Demicannon. You are likewise to understand that the Demicannon should be fortified so well as the Saker: the cube of the diameter of the Demicannon is 274, of the Saker 52, the weight of the Saker 1600, what should the weight of the Demicannon be; then say as before, as 52 (the cube of the bore of the Saker) is to 274 (the cube of the Demicannon bore) so 1600 (the weight of that Saker) is to 8431, the weight that such a Demicannon should be of, that can bear such a proportionable charge, according to the Saker: But suppose the Demicannon to be no more than 6000 weight, then you must multiply 6000 by 20 Pound and 13 ounces (the charge already calculated) divide by 8431 the weight, and

y

you ſhall find 14 pound 13 ounces, which is a ſufficient charge for that Peece: thus you are always to take care of over-loading your Peece, which errour divers run into, when they call a Peece a Demicannon, they preſently load her with ſo much as is allowed for ſuch a Peece ſo named, ſeldome examining, whether the Peece have metal enough for ſuch a charge; by which miſtake they ſtand in danger of their own lives, and others too, which are about them; which may be eaſily prevented, as is above declared.

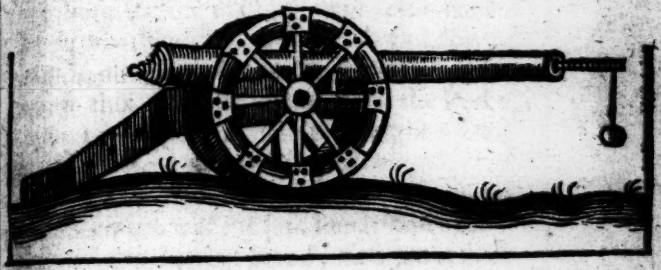
CHAP. 33.

To find whether a Peece of Ordnance be true bored or no.

YOu muſt provide a Pike-ſtaffe, about a foot longer than the bore of your Peece; and at the end thereof faſten a Rammer head, that will juſt fill all the bore under the touch-hole, and at the other

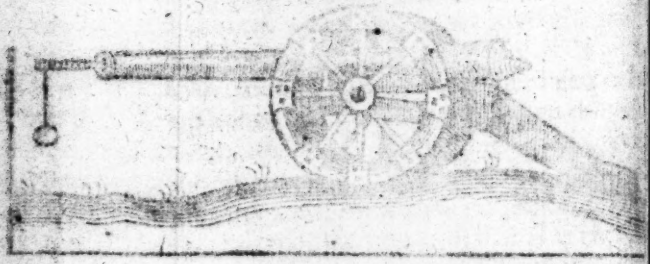
end of the ſtaffe you muſt bore a hole, big enough to put thorow a rod of iron, which muſt hang from the ſame; and at the other end of the rod muſt be made a weight about the bigneſſe of a Saker ſhot; this is done; to make the pikeſtaffe and rammer head to lie with the ſame part upward, when they are taken out of the Peece, as they did when they were within the Peece: then you muſt put your Inſtrument, thus prepared, into the Peece; letting the iron ball (that is at the end of the rod, which is put thorow the hole bored acroſſe the pikeſtaffe) hang perpendicular; then take your priming Iron, or ſome other Bodkin, and put it down the touch-hole, to the rammer head; making a mark therewith: this done, draw out your Inſtrument; and lay the ſame on a long table, with the Iron ball hanging off the end, perpendicular, as it did when this Inſtrument was in the Peece; then obſerve whether the mark you made upon the rammer head, when it was in the Peece, be juſt on the upermoſt part of the ſame; if it be, the bore at the Peece lyeth neither to the right, nor left hand; if you find it a quarter of an inch on the right or left hand, ſo much lyeth the bore either

The Figure of the Instrument within the Peece, and of the Iron ball hanging at the end of the staffe, that afterwards when it is laid on a Table, by help of the ball, it may lie with that part upwards as it did in the Peece.



The Figure of the Instrument laid upon a Table, that by help of the ball of Iron, hanging perpendicular at the end of the Table, it may represent how the Instrument lay in the Peece, and whether the Rammer head be touched or marked on the upper part or not: the Instrument lying (when marked) in the Peece.

Place these two Figures folio 69, in great F.



to the right, or left; and the Peece in shooting must be ordered & charged accordingly.

By this aforesaid, you may find whether the bore incline to the right or left: but to know whether it ly also upwards and downwards, and not in the middle, that way: To know this, find the diameter of the Peece at the touch-hole, as is before taught; then take a wire and bend it a little at the very end, that it may catch at the metall, when you draw it out of the said touch-hole: after this wire is thus prepared, first put it in at the touch-hole, till it touch the bottom of the metall in the Chamber, then holding it in that place, make a mark upon that wire, just even with the said touch-hole, afterwards draw up the wire until it catch at the metall on the top of the Chamber, and holding it there make a mark, as before; the difference between the two marks is the just wideneſſe of the Chamber, and the distance between the first mark and the end of the wire (having half the diameter of the Chamber of the Peece substracted from it) will leave half of the diameter of the Peece, if the Peece be true bored; but if this number be more than half the diameter,

then the bore lyeth too far from the touch-hole, and the upper part of the metal is thickeſt; but if leſſe, the under Part hath moſt metal.

Example.

Firſt, I find the diameter of the Peece to be 12 inches at the touch-hole, then with my wire I find the bore to be in diameter four inches: to the bottom of the metal it is ſeven inches and an half; the half of the diameter or bore is two inches: which being added to the diſtance from the ſecond mark on the wire, or ſubſtracted from ſeven inches and an half the firſt mark; leaves five inches and an half, which is leſſe than half of the diameter you firſt took, by half an inch: therefore as I ſaid before, the greateſt part of the metal is under the bore, and the Peece likeſt to break above; alſo when you make the diſpart for that peece, you are to make it half an inch ſhorter than before, the like obſervation you muſt have to make it longer, in caſe the m tal be thickeſt in the upper part.

Thus I hope I have given reaſonable ſa-

tis-

tisfaction concerning this point, and I am sure on that manner as was never taught before: the truth is, there was never any way taught before that could perform this thing, the peece lying in its carriage; and how laborious it is to handle a great peece out of a carriage, let Gunners judge: I made two such Instruments as are taught by Master *William Bourne*, in his Book, called *The Art of shooting in great Ordnance*, *Chap.* 2. but neither I, nor I believe himself, could ever use them, when the piece is in its cariage.

CHAP. 34.

A description of all sorts of Ordnance from the Cannon, to the base: of their weight, loading, shot, and all other things appertaining to them.

Of the Cannon.

A Cannon is eight inches diameter in the bore, she is also commonly 8000 weight, and about 12 foot long, the

load of Cannon powder is two diameters of powder, which is 32 pound eight ounces: the ſhot ſeaven inches and an half high, weyeth 58 Pound: the length of the ladle 24 inches, and the breadth thereof 14, three quarters.

Of the Demicannon.

Demicannons of the greateſt ſize are ſix inches three quarters in diameter of the bore, the ſhot ſix inches and five eight parts of an inch in height, weighing 36 pound: the weight of the peece 6000 pound; and in length 12 foot: and requireth for its charge in Cannon powder 18 pound, being neer the filling two diameters of the Peeces bore; the length of the ladle 23 inches, lack one quarter, and the bredth 12 inches.

The ordinary Demicannon, the height of the bore is ſix inches and an half; the height of the ſhot ſix inches and one ſixth part, the weight of the ſhot 32 pound, the weight of the peece about 5600 pound; the peece is in length about ten or eleven foot; and

and her charge in powder is about 17 pound and 8 ounces: the length of the ladle is 22 inches, and the breadth thereof twelve: Another sort of Demicannon are in diameter of the bore six inches and a quarter; the height of the shot six inches, the weight 30 pound; the weight of the peece 5400, the length sometimes twelve, sometimes ten, the charg in powder 14 pound: the ladles length 20 inches, the bredth eleven and an half.

Culverings.

Culverings of the largest size, diameter of the bore five inches and an half, of the shot five inches and one quarter, the weight of the shot twenty pound, of the peece 4800: their length ten, twelve, or thirteen foot, their charge in powder twelve pound eight ounces; which is near two diameters and an half of powder, the length of the ladle near sixteen inches, the bredth ten.

Ordinary whole *Culvering*, the height of the mouth of the peece five inches and one quarter; the height of the shot five inches, the weight seventeen pound five ounces; the weight

weight of the peece 4500: the length of the peece twelve foot, the load in powder eleven pound six ounces, the length of the ladle fifteen inches, the bredth nine and an half; with such a peece as last named, I found at the leagure before *Worcester*, that it carried 400 yards point blank, & 800 by the metal.

Culverings of the least size, the height of the bore five inches, the height of shot four inches, and three quarters; the weight almost fifteen pound; the weight of the peece 4000: the length twelve foot, the charge of it in powder ten pound, which is much about two diameters and an half; of the bore full: the length of the ladle fourteen inches and one quarter, the bredth nine.

Demiculverings.

The elder sort of *Demiculverings*, the height of their bore is four inches and three quarters; the height of the shot four and a half; the weight twelve pound and an eleven ounces, the weight of the peece 3000, the length sometimes ten, twelve, or thirteen,

the

he charge for this peece 8 pound and an alf; the length of the ladle thirteen and an alf, the bredth eight and a half.

The ordinary *Demiculvering*, the bore our inches and an half, the ſhot four and ne quarter, the weight ten pound and ten unces and half; the uſual weight of the eece 2700: the length ten foot, requireth or her charge in powder ſeven pound and ne quarter; the length of the ladle twelve nches three quarters, the bredth eight in- hes.

Demiculvering lower than ordinary, the eight of the bore four inches and one uarter; the height of the ſhot four inches; he weight nine pound, the peece 2000 eight: the length nine or ten foot, their harge in powder ſix pound and a quarter: he length of the ladle twelve inches, the redth eight.

Sakers.

Some *Sakers* of the oldeſt ſort, caſt in the eign of *Henry* the eighth, and *Edward* the ixth, are four inches in height at the mouth, the

the ſhot 3 inches 3 quarters, the weight o
the iron ſhot 7 pound 5 ounces, the weigh
of the peece 1800, the length either 9 or 1
foot, and requireth for her charge in Can
non powder 5 pound, it being found by ex
perience to be ſufficient, the length of th
ladle 11 inches, and the bredth 7 and
quarter.

Sakers ordinary, the diameter of their bor
three inches three quarters, height of th
ſhot 3 and an half, weight ſix pound
weight of the peece 1500, length 9 foo
charge of cannon powder 4 pound, leng
of the ladle 10 inches and an half, th
bredth 6 and three quarters.

Sakers lower than the former, the diame
ter of the bore 3 inches and an half, th
height of the ſhot 3 and a quarter, th
weight 4 pound 3 quarters, the weight
the peece 1400, the length 8 foot, and bu
neth in powder 3 pound 6 ounces, the leng
of the ladle 9 and 3 quarters, the bredth
inches and an half.

Minion

Minions.

Minions of the largeſt ſize, are three inches and a quarter Diameter in the mouth, the ſhot 3 inches, the weight 3 pound and three quarters, but it were better if the ſhot were 4 pound weight, then it would not have too much vent, as one of 3 and 3 quarters hath, the weight of the Peece 1000, ſometimes 800, the length 8 foot, comporteth in powder, if of 1000 weight, 3 pound and a quarter, if of 800, a pound and a half, length of the ladle 9 inches, the bredth 5.

The ordinary *Minion*, the mouth 3 inches high, the ſhot ſhould be 3 inches wanting half a quarter, the weight 3 pound and a quarter, the weight of the peece 750, the length 7 foot, the charge in powder 2 pound and an half, the length of the ladle 8 and a half, the bredth 5.

Faucons.

Faucons.

The height of the mouth of the peec
3 inches 3 quarters, the height of the ſh
2 inches and 5-8 the weight, two pound and
half, the weight of the peece 750, the leng
7 foot; it burneth in powder 2 pound and
quarter, the length of the ladle 8 and a qua
ter, the bredth of the plate 4 inches and
halfe.

Fauconets.

The mouth of the peece is 2 inches and
quarter high, the ſhot 2 inches and half
quarter high, the weight of the ſhot o
pound 5 ounces, the weight of the pee
400, the length 6 foot, the charge o
pound and a quarter, the ladles length 7 a
an half, the bredth 4 inches.

Rabanet.

The *Rabanet* hath in diameter at the bo
one inch and an half, the height of the ſh
on

one inch and 3-8 the weight 8 ounces, of Iron, and of Lead 12, the weight of the peece 300, the length 5 foot and an half, the charge in powder three quarters, the length of the plate of the ladle 4 inches and a quarter, the bredth 2 and an half.

Base.

The diameter of the bore of this ſmall peece is one inch and a quarter, the height of the ſhot one inch and half a quarter, the weight 5 ounces of iron and 8 of lead, the weight of the peece 200, the length 4 foot and a half, length of the ladle 4 inches, plates bredth 2 inches.

In all this *Chapter* I have made the ladle but three diameters of the ſhot in length, and three fifth parts of the circumference: From the *Cannon* to the whole *Culvering*, I allow the charge of powder to be about two diameters of the peece: From the *Culvering* to the *Minion*, the charge to fill two diameters and an half. All from the *Minion* to the *Baſe*, three diameters full of powder.

CHAP.

CHAP. 35.

Of iron Ordnance, what quantity of powder to allow for their loading.

FIrſt, you muſt calculate a charge of powder for the ſaid iron peece, as if it had been a braſſe piece, and in caſe you have not the weight of the ſaid iron peece, you muſt find it as you are taught in *Chap.* 31. of this book; when you have found as I have taught in *Chap.* 32. how much powder would load the ſame if it were of braſſe, then juſt three quarters ſo much is ſufficient to load an iron peece.

Example.

A braſſe *Saker* of 1500 weight, requires four pound, what will an iron *Demiculverin* of 2800 weight require, you ſhall find that ſuch a *Demiculverin* of braſſe would have required 7 pound and an half, as in *Chap.* 32. as thus, the Cube of the bore of a *Saker*, three inches and three quarters, is 52|73 of the bore of a *Demiculverin* four inches

inches and a half is 91 11/15 then if 52 7/8 require four pound, what will 91 11/15 require (the cube of the *Demiculvering*) you shall find six pound 15 ounces, so much shall serve for a brasse Peece, if so well fortified as the Saker, the which we will likewise examine, as 52 7/8 (the cube of the Saker bore) is to 91 11/15 (the cube of the Demiculvering bore) so 1500, the weight of the Saker, is to 2592 the weight that such a Demiculvering should be of, that burneth six pound 15 ounces of powder: to find what a Demiculvering of brasse of 28 hundred will require, say thus, if 2592 require six pound 15 ounces, what will 2800 aske? multiply, and divide, and you shall find 7 pound 8 ounces, of which number you must take three quarters for a charge for the said Iron *Demiculvering*, being 5 pound ten ounces, a sufficient quantity to load such a Peece withall.

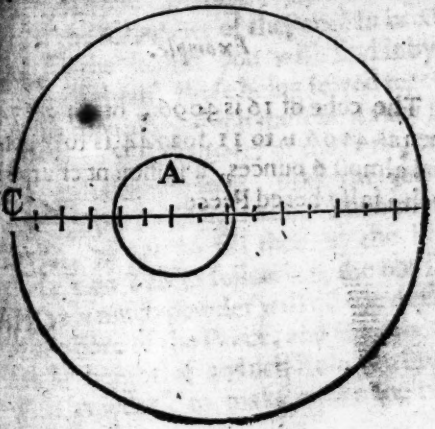
Also what ever you find in the 34 *Chapter* for Brasse Peeces, take three quarters thereof for the charge of your Iron Peece, if it be near that weight.

CHAP. 36.

To know what quantity of powder should be allowed to a Peece not truly bored.

SUppose the diameter of the metall of the Peece at the touch-hole be 16 inches, and the diameter of the bore five and a quarter, the weight of the Peece 48 c. or as you may find by *Chap.* 31. such a Peece you may find by *the Rule of Proportion*, in the 32. *Chap.* requires eleven pound for her due charge, being near two diameters of her bore in powder: by my Instrument spoken of before, I try whether she be true bored, and by the mark on the Tampion, at the end of the pike, I find the sole or bore to be one inch out of his place, or one inch from the middle of the metall, then I conclude, that the thinnest part of the metall, is inches 2 three eight parts: and the thickest side 3 three eight parts: by which it appears that one side is just two inches thicker than the other side, as you may see plainly by this figure, where the line divided being the diameter;

meter; every diviſion ſignifieth one inch; the outward circle the out ſide of the mettall of the Peece; the inner circle ſignifieth the borer which you may ſee to lye juſt one inch from his true center, of the our-moſt circle; how to calculate a charge for this Peece you ſhall preſently underſtand; you muſt ſuppoſe as if this Peece were fortified no more, but onely ſo much, as the thinneſt part of the metall is: which here will appear to be 4 inches and three eight parts of an inch, and the half of the diameter you ſhall find by adding half, that of the



bore 2 five eight parts, to the aforesaid num-
ber, to be just seven inches from A the cen-
ter of the bore in the figure to C the thin-
nest part of the metall, the whole diameter
being 14: the second diameter being found
is the true diameter, which you must pro-
portion your charge by: the former being
16 inches, if the bore had been placed in the
true center: then as the cube of 16, is to
the cube of 14, so eleven pound of powder
(being the charge calculated before for a
peece of 16 inches diameter) is to such a
charge as shall suffice.

Example.

The cube of 16 is 4096, of 14: 2744
then as 4096, is to 11, so 2744, is to 7 pound
and almost 6 ounces, a sufficient charge for
such a false bored Peece.

CHAP.

CHAP. 37.

How to make Cartredges for Ordnance, and how to fill them by help of an Inch Rule, to so many pounds and ounces as you please.

TO make your *Cartredges*, take canvas, such as the powder will not creep thorow, and let it be in bredth (I mean that piece of cloth wherewith you will make one *Cartredge*) just three diameters of the Chamber of the Peece in bredth; and for the length you will find it by the filling of them, these being sewed together upon a mould, which must be a very little lesse than the diameter of the bore, and a hour 4 diameters long, upon this you may make paper *Cartredges* also: when they are made, ye are to fill them by the help of those two Tables following; the one shewing how much powder will fill one diameter of the bore of the Peece, and the other how far in height of an Inch Rule you must fill with powder, to make either one pound,

two

two or three pound, as the title on the top will shew you: you may use that of these two ways (as stands best with your convenience; and best befits your use: If you are to fill *Cartredges* for a *Demicannon*, and you find that the *Demicannon* is able to bear two diameters of powder in her load, by this Table over against 6 inches and an half *Demicannon* diameter; you shall find eight pound, eleven ounces and an half, to fill one diameter of the said Peece: the double of which is 17 pound and 7 ounces, a fit charge for the Peece.

If you fill a *Cartredge* for a Saker with five pound of powder; to know how full 5 pound will make it, look in the second Table, and first against three and three quarters Saker bore; you shall find 3 pound will fill 6 inches and 3 quarters, in height of your *Cartredge*, and two pound more will fill 4 inches and an half; which being added together, shews that your *Cartredge* is to be filled just eleven inches, and one quarter for 5 pound.

The
owl

The first Table shewing how much canon powder will be contained in one diam. of the bore of any powd.

Inch	parts	pound	oz	parts
2	0	0	[illegible]	
2	1.4	0	[illegible]	
2	1.2	0	7	3.4
2	3.4	0	10	1.2
3	0	0	13	1.2
3	1.4	1	1	1.2
3	1.2	1	5	3.4
3	3.4	1	10	1.2
4	0	2	0	1.2
4	1.4	2	7	1.2
4	1.2	2	14	
4	3.4	2	6	1.4
5	0	3	15	1.2
5	1.4	4	9	1.2
5	1.2	5	4	3.4
5	3.4	6	0	3.4
6	0	6	13	3.4
6	1.4	7	12	
6	1.2	8	11	1.2
6	3.4	9	12	3.4
7	0	10	14	1.2
7	1.4	12	2	
7	1.2	13	6	1.2
7	3.4	14	12	1.2
8	0	16	4	1.2

The second Table sheweth how far either one, two or three pound of powder will fill in the bore of any Peece, the Diameter of the bore being given.

Inch	part.	Inch	part (1 Pound)	Inch	part. (2 Pound)	Inch	part. (3 Pound)
2	0	8		16		24	
2	1.4	6	1.4	12	1.2	18	3.8
2	1.2	5		10		15	
2	3.4	4	1.6	8	1.3	12	1.2
3	0	3	1.2	7		9	1.2
3	1.4	3		6		9	0
3	1.2	2	5.8	5	1.4	7	7.8
3	3.4	2	2.4	4	1.2	6	3.4
4	0	2		4		5	7.8
4	1.4	1	3.4	3	1.2	5	1.4
4	1.2	1	1.23	3		4	11.16
4	3.4	1	3.8	2	3.4	4	1.8
5	0	1	1.4	2	1.2	3	3.4
5	1.2	1	1.16	2	1.8	3	5.16
6	0	0	14.16	1	3.8	2	3.6
6	1.2	0	12.16	1	5.8	2	1.4
7	0	0	10.16	1	11.16	1	15.16
		1 Pound.		2 Pound.		3 Pound.	

Whereas Fractions usually are placed one figure over the other, with a line between them, in this Table they are placed one by the side of the other with a point between the Numerator and Denominator, as thus, 1.2 signifying one half, 5.8 five eight parts, &c.

To fill *Cartredges* for Minion, 3 pound, look in the second Table, and in the Culumne of 3 pound, you shall have (right against 3 inches and one quarter Minion bore) 9 inches just; to be the height of the powder in the *Cartredge*, for the loading that Minion 3 pound.

To fill for a *Demiculverine*, which requireth 2 Diameters and an half for his charge, look in the first Table, right against 4 inches and an half, you shall find 2 pound 14 ounces; to fill one Diameter of the said Gun which being doubled maketh 5 pound and 12 ounces; and one half diameter also added to that, maketh the Charge to be 7 pound 3 ounces.

Now having fully shewed how to make powder, to try the strength of powder, to know what shot and powder is meet for every Peece: to find whether the Peece be true bore or not, to load a Peece with discretion if not true bored: to make the dispart: and also to know the difference between Iron and Brasse Peeces: I shall come to touch how to make a good shot, either at point-blank, or at random; with as much ease and plainness, as ever was before taught by any whatsoever.

CHAP.

CHAP. 38.

How to give levell with a Peece of Ordnance, to make a ſhot at any mark aſſigned, within point-blank.

SEt your diſpart on the *Muſſell ring*, juſt over the center of the mouth of the Peece; which you may beſt doe, by putting a ſtick a-croſſe the bore, and dividing it into two equall parts, then with a plumb-line hanging over the mouth of the Peece, being guided by the divided ſtick, you ſhall have a good ayme where to ſet your diſpart; this being done, go to the Baſe-ring, if the Peece be true bored, then find out which is the higheſt part, and middle of that ring, but if the Peece be not true bored, then find which part of the Baſe-ring, is juſt over the Cylinder; and take that for your true line. When you have found out both the Diſpart, and placed it, and alſo found what point in the Baſe-ring is to anſwer it, then make ſome very ſmall mark on the

Base-ring in that place, hold your head about two foot from the Base-ring, and there you may best observe, as the Peece is traversing, when you are in a direct line with the Mark; this being done, give one of your Matrosses order, to raise, and fall the Peece with his Hand-spike, as you shall appoint him, until you can (holding your head about two foot from the Breech of the Peece) with your eye perceive the mark at the Base-ring, and the top of the Dispart in a direct line with the mark you must shoot at: at that instant stop the motion of the Peece with a Coyne, that it may remain as you have directed it: Then prime the Peece and give fire.

Before you place on your Dispart, you are to observe whether the ground be level, on which the wheels of the Gun stand, if if they are not one higher than the other: if the Trunnions are placed just over the Axtree of the Wheels, or not: Whether one Trunnion lye higher on the Carriage than the other: Whether the Gun be truly placed in the carriage or not; I mean not swerving more to one side than the other: Whether the said Carriage be truly made or not:

And

And lastly, whether the Axtree be placed just a-crosse the Carriage or not.

How the Carriage of a Peece should be made.

Measure the length of the Cylinder of the bore, and once and an half that length should be the length of the Carriage: Also measure the Diameter of the bore of the Peece, the Planks ought to be four of those Diameters in depth at the fore-end, in the middle three and an half, and at the end next the ground two and an half, also they ought to be in thicknesse one Diameter: The Wheels should be one half the length of the Peece in height, the Saker and Minion-wheels must exceed the former by one twelfth part, the Faucon and Fauconet by one sixt part.

If you find that the ground is not levell, on which your Peece stands, and that one wheel is higher than the other, and the Trunnions out of due place, the Peece not lying truly in the Carriage, and that also not truly made, you must get these things amended, or else never look for good service from such a Gun, being so ill planted.

CHAP. 39.

How if the first shot (by reason of some fault spoken of in the last Chapter) doe carry to the right, or left, or over, or under the Mark, to amend it in the making the next shot.

AFter you have made one shot, and find the Peece carry just over the Mark, then doe all as hath been before taught again, and when as your Peece lies directly against the Mark, observe how much the last stroke of the shot is above the Mark, so much longer make your Dispart, that the top of it may be just seen from the Britch of the peece in a direct line with the stroke of the shot; when it is of this length, then levell your Peece with this new Dispart, to the assigned mark; Give fire, and without doubt it will strike the same.

If the first shot had struck under the Mark, then

then bring the Peece in all points as before to passe, mark how much of the Dispart is over the stroke of the shot, and cut it just so short, as being at the britch you may discern the top of it, the mark on the Base-ring, and the stroke of the shot in a right line, when you perceive it is of such a length, levell the Peece to the assigned mark, as at the first, then prime and give fire.

If the first shot had struck on the right hand of the Mark, to mend it, you must levell the Peece as formerly, you standing behind the britch of the Peece, observe the stroke of the shot over the Dispart, that part of the Base-ring as you at that instant look over in a right line towards the Dispart, and the stroke of the shot, set up in that place a pin with a little soft wax on the Base-ring, so this pin will be in a right line with the Dispart and stroke of the shot: this being done, levell your Peece to the mark assigned, by this pin and the Dispart, and without question you will make a fair shot.

For when you levell by the metall of the base-ring where the pin is placed and the mark, the Peece standing at that direction look over the top of the Dispart, from the

notch in the Base-ring, and you shall find the peece to lie just so much to the left, as the former shot struck to the right from the assigned mark, which should in all likelyhood now strike the mark.

But if the shot be both wide and too low, then you must use both directions above taught, to make the next shot: First regulate the dispart by cutting it shorter, according as the shots mark is lower than the assigned Mark; when this is done, then proceed to my directions to mend shooting wide. These things done with care and diligence, cannot choose but mend a bad shot.

CHAP. 40.

Of the Gunners Quadrant which is to be used in shooting at Random, and what portion the Degree of a Quadrant is.

YOU are to understand that every Circle great and small is divided to 360 Degrees, the cause of this di-

division is, because the Sun maketh his motion in little more than 365 dayes, through the *Zodiack* or twelve Cœlestiall Signes, which is a Year; now 360 is the next even number that can be divided into quarters and half quarters, fit for use; and the Sun dividing his Circle thus, does give example to all Mathematicians to divide all accordingly, a quarter of which Circle we call a Quadrant, containing 90 Degrees, you must have a ruler fastened to one side of such a quarter of a Circle or Quadrant, that must be put within the concave of the Peece, with a peece of lead at the end, to make the said rule lie close to the bottom of the mettal within, the Quadrant hanging without, by the plumb-line you shall find how many of those degrees the peece is elevated unto; and the Quadrant being thus placed, you may mount the Peece to what Degree you shall find fit to shoot by.

I will not make any figure of a Quadrant, or give other directions for the making of it, because they which want one may buy it in divers places in *London*, but will proceed to teach the use thereof in Gunnery.

Every one that will learn to shoot at Ran-

dom, must draw his Peece into a levell ground, where first shooting levell, he must observe that distance in feet or paces, then mount his Peece to one Degree, and mark where that shall graze: thus find the distance of every Degree, from the levell to the 10th. Degree, and by these distances make a Table, to which annex the Degrees against the distances, by which Table you may (using the Art of proportion) find how far another Peece will convey her shot from Degree, to Degree: but in case you cannot have liberty, nor powder to doe all the aforesaid, I will tell you what I have done my self; out of a Saker eight foot long, loaded with three pound of powder, at the first shoot being one degree mounture, it conveyed her shot 375 yards, or 225 paces: the next shot was at five Degrees Random, at which mounture she conveyed 416 paces, and the next tryall was at seven Degrees mounture, the Random produced 505 paces, the last tryal was at ten Degrees, which conveyed 630 paces, five foot to a pace.

Whilest I made these shots I loaded the Peece my self with loose powder exactly weigh-

eighed, and weighed the wad, alſo I beat own the ſaid wad with four ſtroaks, ſo ar as I could with the ſame ſtrength I d the time before, alſo I let the Peece cool it ſelf, ſtaying above half an hour be-wixt each ſhot, I put no wad after the bul-t becauſe the Peece was mounted. I am re if I had not taken all this care, I ſhould ot have profited by all theſe ſhots: When eſe were made, I tryed the ſtrength of e powder, the which I carefully noted own, alſo I kept ſome of it to compare a-ain when I ſhould have other powder; theſe ings I would adviſe every one to obſerve, at meaneth to be cunning in ſhooting at andom.

It is the duty of a maſter Gunner of a own or Fort, to draw an exact deſcription f the ſaid Garriſon, and of every object as yeth near his Works within the reach of is Guns, by which means he ſhall not be roubled to take the diſtance, but be ready t all times to know the diſtance by his Map: hen after he hath made one ſhot, he by the *Rule of Proportion* may be able to make ano-her ſhot to any diſtance he pleaſeth, *exāple*; uppoſe I find the diſtance by my Map where the

the first shot grazed, to be 704 paces; t
mounture of the Peece being four degre
how much must I mount the peece to co
vey her shot 900 paces, you must propor
on these distances of Random to those in
Table; say, if 407 Paces require 370 pac
(as the Table hath it at four Degrees
Random) what number to be found in t
Table against that Degree which I m
mount the Peece unto will 900 requi
Multiply and divide, and you shall find 4
which number is not to be found in the T
ble, but the next lesse is 461, against
Degrees, and the next greater numbe
505, against seven Degrees, the differe
between these two numbers is 44, wh
shew that the Peece must be mounte
six Degrees and one third part, for to re
the distance of 900 paces, because 461 is
lesse than 473, it being one third part alm
of 44 the difference:

He

Here I preſent unto your view the Table of Randoms which I made by my own obſervation, deſiring every one if it be poſſible he can get pouder to make one by his own experience, and always remember to keep ſome of the ſame Gunpowder to try its proportion, as I have taught in the 6 *Chap.* with any other powder that afterwards he ſhall have occaſion to uſe; for this is one of the excellenteſt properties that belong to a Gunner, and without this knowledge he ſhall never be able to make good ſhot, becauſe at the time of a Leagure he muſt often change his powder, at ſuch a time I have had nine pound of one ſort, as good as 15 of another ſort, as both by ſhooting, and by my Inſtrument, I have experimented.

Degeees.	*Randoms.*
1	225
2	274
3	323
4	370
5	416
6	461
7	505
8	548
9	589
10	630

CHAP.

CHAP. 41.

How to make an effectuall ſhot out of a Peece of Ordnance at Random.

EVery one that hath charge of a Gun must at one time or other obtain leave of his ſuperiours, to make two or three ſhots at leaſt out of his ſaid Peece, and meaſuring the diſtance from the Platform to the firſt graze of the ſhot, you muſt apply it to my Table, and by *the Rule of Proportion*, as in the laſt *Chapter*, find what Degree you ſhall need to mount the Gun for any other ſhot at another time when you ſhall have occaſion.

Firſt, When you come to your Peece, ſet your Boudge barrel on the wind-hand thereof, and cauſing one of your Matroſſes to hold the ſame aſlope, thruſt your Ladle into the ſame, filling it full of pouder, and then ſtrike it with a Ruler, (for by ſo doing, you may know juſt how many pounds and ounces you load your Peece withall) then fixing your

your thumb just under the staffe of the Ladle, thrust the same home to the Chamber of the Peece where the powder lyeth, turning the Ladle so as your thumb be directly above the staffe, and in so doing, the powder will empty it self out of the Ladle cleanly, then drawing out your Ladle, with the Tampion at the other end of that staffe, thrust home the powder, causing your assistant to hold his finger or thumb close on the touch-hole, then taking a close round wad of hey, or untwisted rope, thrust in the same with your Rammer head that is on the Spunge staffe, (for if you should do it with that on the Ladle, it would soon loosen the plate of the Ladle) and with it give three or four good stroaks, when you have thus done put in the bullet without any wad, because the Peece must be elevated.

If you charge your Peece with Cartredges, which I count the best way, providing, (that although they hold the like quantity of powder) they be all of one thickness: otherwise you should find much deceit in shooting: slit it a little in that place, which must be conveyed under the touch-hole; then put it home with the end of the Rammer

mer, and afterwards put home to it a good wad, then turn in the ſhot, the Peece being loaded, as I have taught you, take the diſtance to the mark, by ſuch means as I teach in the 59 Chapter of this Book: and alſo obſerve, how many degrees the platform is either higher, or lower, than your mark with your Quadrant: after you have done thus, and calculated what degree you muſt mount the Gun unto, to reach the mark, if the ſaid mark be under the platform, ſubtract the profundity, out of the degrees of random; but if the ſaid mark be higher than the platform, adde the degree of that altitude, to the degrees of Random, and at the corrected degrees, mount your Peece: by putting the Ruler of the Quadrant into the mouth of your Peece, marking diligently till the plumb-line, which proceedeth from the center of your Quadrant, cut thoſe degrees and parts of a degree (unto which you are to mount the Gun) in the Circumference; Make your ſhot, for without queſtion, you may either ſtrike or come very near the mark.

Ex-

Example.

Suppose that when you make triall of your Gun, as is spoken of in the beginning of this Chapter, you find that at seven degrees of Random upon a levell ground, the shot is conveyed 700 paces, you being called out upon service against a Citie, or other fort, and being appointed to play your Gun towards it; you also finding it to be beyond point-blank; the distance being 560 paces; also that the said place is lower than where you must plant your Gun, by one degree, and one fixt part, then to know the degrees of mounture, say, as 700 paces (being the range of seven degrees, out of your Gun formerly) is to 505 (the distance of Random found in my Table of Ranges for seven degrees) so 560 (the distance to the mark) is to 404; this number is to be found in the Table or the neareſt number unto it; and againſt that the degrees: the parts of the degrees must also be found, by substracting the neareſt leſſe number, out of the neareſt great number: thus looking in the Table the neareſt leſſer number is 370, the neareſt greater

greater 416: one ſubtracted from the other the difference will be 46:404 differeth from 416 but 12 parts, which is a little above one quarter, ſo that your degree of Random is four and three quarters, or five lack one quarter; becauſe the mark is lower than the platform, ſubſtract one degree and one fifth part or ten minutes out of four degrees, and three quarters; or 45 minutes, and the remain is three degrees and 35 minutes, the true height to which your Peece muſt be elevated, to reach the mark.

If the ſhot graze either to the right or left, you are to mend it by the directions in *Chap.* 39. but if over, then you are to conſider the diſtance, how much it is beyond; and the next ſhot abate ſo many minutes out of your mountures, as the diſtance beyond the mark does require: if ſhort, you are to adde to your mounture, as if the like number of paces that you ſhall find ſhort, had been wanting to your diſtance, then proceed as before.

Example.

Suppoſe the ſhot graze over the mark 20 paces, ſubſtract this 20 out of 560 the di-

distance, and mount the next shot according as if the mark were but 540 paces distant. If 20 paces short, make the next shot at 580 paces, I mean at that degree that will reach so far.

CHAP. 4.

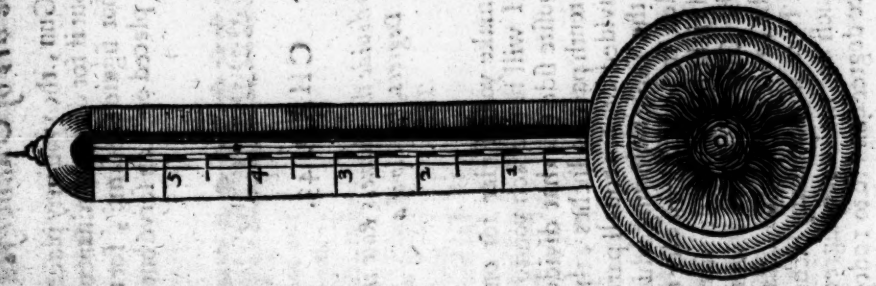
How to make another sort of Instrument, called the Gunners Rule: which will serve to elevate a Peece of Ordnance, with more facility than the Gunners Quadrant.

BEcause the Quadrant afore mentioned cannot be conveniently used at all times, for if the wind be high, you will have very much adoe to make the plumet stand still, besides, it is a great trouble to take the profundity of a vally, and the altitude of a hill, when the mark is not level, also in field service you cannot use it, (but onely in a Leagure or out of a Garrison when it is beleagured) the plumb-line is over long before it stands still: to remedy all

this, the Gunners Rule was invented, the figure whereof you may see in the following page. This rule must be some 10, 12, or 14 inches long, according as the Gun will require, it must have a long slit down the middle thereof, dividing it almost into two, but onely held together by a little peece at the head and the foot, which must be circular according to your Gun, as you may see in the figure, where the Instrument is described, standing upon the britch of a peece of Ordnance: in the middle of the small and narrow slit you must place a lute string, and upon that a bead, which you may move up and down at pleasure, or if you cannot get a lute string, you may use a good thrid instead thereof, this bead must be set to such an inch, as you find is agreeable to such a degree, that you must mount your Gun unto, in this figure, the bead is at four inches and half a quarter: on one side the slit must be placed a division of Inches and quarters or tenths of Inches, on the other side must be placed the Degrees and Minutes, when you shall find by the length of your Gun, how many Inches and parts goes to make one Degree. If you make this Ruler for

one

See here the Gunners Ruler standing on the britch of a Peece.



one onely Gun, then you may place on the Degrees, but if for divers Ordnances, then you must not figure the same, for the degrees once placed on, can serve but for one Gun.

CHAP. 43.

How to divide the Gunners Rule into Degrees, by help of a Table.

IF you make your Ruler for one Gun onely, I will here teach you to divide the oppoſite ſide (to that divided into Inches and tenth parts of Inches, that is every Inch divided into ten equall parts) into Degrees by the Table following, which Table is divided into 10 Columes for the ten degrees, and right before this diviſion is the length of the Gun ſet down, which you muſt enter the Table with all, and juſt againſt it you ſhall have in how many Inches and parts of an Inch doe make one degree, two degrees, three degrees, and ſo to 10 degrees.

If

A *Table* by which you may place the Degrees on the *Gunners Rule*; fitting it for any Peece from five foot long to fourteen foot long, and by help of which any Peece may be levelled to any degree without the help of a *Quadrant*, *Ruler*, or any other Geometricall Instrument whatsoever.

The length of the Peece.	1 *deg.*	2 *deg.*	3 *deg.*	4 *deg.*	5 *deg.*	6 *deg*	7 *deg*	8 *deg.*	9 *deg.*	10 *deg.*
5 Foot long.	1 3	2 6	3 8	4 11	5 14	6 16	7 19	8 22	9 25	10 28
5 Foot and an half.	1 14	2 28	3 42	4 56	5 70	6 84	7 98	9 12	10 26	11 40
6 Foot long.	1 22	2 44	3 66	4 88	6 10	7 38	8 58	9 78	11 8	12 29
6 Foot and an half.	1 36	2 72	4 8	5 44	6 80	8 17	9 53	10 89	12 25	13 63
7 Foot long.	1 47	2 94	4 41	5 88	7 35	8 82	10 30	11 77	13 24	14 73
7 Foot and an half.	1 58	3 14	4 71	6 28	7 85	9 42	10 99	12 57	14 14	15 71
8 Foot long.	1 68	3 36	5 4	6 72	8 40	10 8	11 76	13 44	15 12	16 82
8 Foot and an half.	1 79	3 58	5 37	7 16	8 95	10 74	12 53	14 32	16 12	17 92
9 Foot long.	1.89	13 79	5 68	7 58	9 47	11 37	13 27	15 18	17 8	18 98
9 Foot and an half.	2 0	4 0	6 0	8 0	10 0	12 10	14 2	16 3	18 4	20 4
10 Foot long.	2 10	4 20	6 30	8 40	10 30	12 61	14 73	16 84	18 96	21 8
10 Foot and an half.	2 21	4 41	6 69	8 88	11 81	13 28	15 48	17 68	19 89	22 10
11 Foot long.	2 31	4 62	6 93	9 24	11 56	13 88	16 20	18 51	20 82	23 14
11 Foot and an half.	2 42	4 84	7 26	9 68	12 10	14 53	16 95	19 37	21 80	24 21
12 Foot long.	2 53	5 7	7 59	10 12	12 65	15 18	17 71	20 25	22 78	25 33
12 Foot and an half.	2 63	5 27	7 89	10 52	13 15	15 78	18 41	21 4	23 67	26 33
13 Foot long.	2 74	5 48	8 22	10 96	13 70	16 44	19 48	21 92	24 68	27 40
13 Foot and an half.	2 84	5 68	8 52	11 36	14 20	27 4	19 88	22 72	25 56	28 42
14 Foot long.	2 95	5 90	8 85	11 80	14 75	17 70	20 65	23 60	26 56	29 53

Place this Table in folio 20, little b.

If your Gun be 12 foot long, two Inches and 53 hundred parts of an inch doth make one degree, five inches, and six parts, (if the inch were divided into 100) maketh two degrees, &c. For I told you before, that you must divide your inch into ten parts, and for more exactneſſe, ſuppoſe every one of thoſe 10 parts to be divided into ten more, which maketh 100, all thoſe parts ſet down in the Table, are ſuch parts.

CHAP. 44.

How to give levell to a peece of Ordnance, with the Gunners Rule, at any degree at Random.

THe peece being loaded in all points as is before taught, and you alſo having brought the peece in a right line with the mark, the Diſpart being placed upon the muſſle ring, place your Ruler upon the baſe ring, and having before all this taken the diſtance to the mark, and found it to be 461 yards: the firſt ſhot you made out of that peece for

practice conveyed her shot 274 yards, at two degrees mounture, according to the rules before taught, 461 yards will require six degrees mounture, then to find by this Table how many inches, and hundreth parts of an inch, six degrees will require, look in the first Table, finding on the left hand, in the first columne the length of the peece 12 foot just, under six degrees in the common angle you shall find 15 inches, and 18.100 parts of an inch; which known, I set the bead that is on the string in the slit to 15 inches, and 13 parts, if the inch be divided into 100, and cause the peece to be moved either higher or lower, untill you see the bead, the top of the dispart, and the mark, all in one line, stop the peece at that position with a coyn, prime and give fire.

If you would shoot by the metall of the peece without a dispart, substract the length of the said dispart, out of the inches found in the Table, and the remainer mount your peece unto; if the dispart had been three inches long, that taken out of the inches found in the Table being 15. $\frac{18\ 100}{}$ will leave 12, $\frac{18\ 100}{}$ to which height in the Rule without a dispart you must mount the peece

CHAP.

CHAP. 45.

How to make use of the last Table, to give levell to a Peece of Ordnance without the Gunners Rule.

IF you have not a Ruler nor Quadrant, and would make a shot just at five degrees elevation, look in the Table, and find the length of the peece, which admit to be nine foot and an half, right against this, in the angle under five degrees, you shall have ten inches, to be the length of any streight stick, which you may set upon the base-ring, and levell over the top of the said stick, as if it had been the bead in the Ruler; thus you may perform as much as with the Ruler; if you will have no dispart upon the peece, take it off, and lay it with the aforesaid stick, from which cut off its just length, the remainer you may use upon the base-ring, for when you have the top of it, the metall of the mussle ring, and the mark in a right line, you cannot fail of making a

good ſhot. If the diſpart in this peece were two inches and an half, this cut from the length of ten inches, the number found in the Table, there will be left ſeven inches and an half, for the length of the ſtick, to be ſet on the baſe ring, to levell the peece without a diſpart.

CHAP. 46.

How to make a ſhot at the enemies lights in the dark night.

WHen you ſhall have occaſion to ſhoot at a light ſeen in the night time, diſpart your peece with a lighted and unſlaming wax candle, or with a lighted peece of match, that you may ſee by the light of the fire in the ſaid Gunmatch, to lay the middle and upmoſt part of the metall, at the tayle of the peece, the top of the match, and the marke in one line, when this is done, give fire.

CHAP.

CHAP. 47

How to make a perfect ſhot in a dark night, at any mark that may be ſeen in the day time, within the reach of the Peece

IN the day time mount your peece (as you are before directed) to reach the appointed marke, and at that time place the mouth or concavity of the peece right upon the ſaid mark, then put the ruler that is fixed to the Quadrant into the mouth of the peece, note what degree is touched in the Quadrant by the plumb-line, and ſet it down in writing, or elſe keep it in memory, after that, let fall a line and plummet down to the ground, from the middle part of the mouth of the peece, in the place where the plummet toucheth the platforme make a marke, then carry your line and plummet to the breech of the peece, and let it hang to the ground, from the middle part of the breech.

breech, there alſo where it toucheth the ground or platform likewiſe make another mark: between each of theſe marks draw a line, and continue that line above two yards beyond each mark, this ſhall be called the line of directions. Now when you will ſhoot in a dark night with that peece at the ſame mark, charge the peece with the ſame quantity of powder, as you did when you found by experience that ſuch a degree which you now muſt mount by, did hit the mark, and alſo with the like weight of ſhot, then bring your Gun upon the line of direction, ſo that the middle of the mouth of your peece, and middle of the breech may be juſt over it, which you may bring to paſs by help of the plummet; when this is done, elevate the peece ſo much by the Quadrant, as you did in the day time, and without queſtion ſhe will reach the mark as before.

CHAP.

CHAP. 48.

How to make a perfect ſhot at a company of horſmen, or footmen, paſsing by the place where Ordnance do lye upon a levell ground, and alſo to make a good ſhot at a ſhip ſayling up a River.

WHen any horſmen or footmen ſhall paſs by a place where a great peece of Artillery doth lye, the Gunner muſt charge the peece before-hand with good powder, and fit ſhot, to this end that the peece may goe off ſo ſoon as fire is put to the ſame: alſo the Gunner in this caſe muſt lay his Gun truly diſparted upon a levell ground, right againſt ſome mark in their way, as againſt ſome tree, buſh, or hillock, and beſt of all if it be upon ſome turning way, becauſe in ſuch a place they cannot depart very quickly, and when the ſaid horſmen or footmen, ſhall come near unto that mark, or be in the turning way, the Gun-

Gunner muſt diſcharge his ſaid peece
them: Likewiſe when a Gunner will ſho
at a ſhip ſayling in a river, he ought to pla
his peece towards a cloud or ſome evide
mark on the other ſide the river, and giv
fire to his peece when the fore part of th
Ship ſhall begin to be between the mou
of the peece and the mark.

CHAP. 49.

How to cauſe that the ſame quantity both of powder and ſhot, diſcharged out of the ſame Peece, ſhall carry cloſe or more ſcattering.

MAſter *John Bate* in his Book o
Extravagants, ſayeth, Take th
quantity of a peaſe of *Opium*, an
charge it amongſt the caſe ſhot, and it wil
make the ſaid caſe ſhot fly cloſer togethe
than otherwiſe it would, this Maſter *Ba*
ſaith, he learned of a Seaman, who had made
tryall hereof, as he ſayes, and unto whom
Maſte

Bee sold some for that purpose; it is probable, for *Opium* is of a congealing narative nature.

CHAP. 50.

How a shot which sticketh fast within the concavity of a Peece, that it cannot be driven home unto the Powder, may be shot out without danger to the Gunner, or hurt to the Peece.

WHen a peece of Artillery is charged with such a Shot as will not be driven home unto the powder, the Gunner, to save this peece from taking, must so imbase the mouth there-that faire water for two or three dayes, ing put in at the touch hole, as severall ets, may run out into a vessel set under the uth of the Gun, to save all the *Salt-peter* it was in the powder; when these things done, the Gunner must prime the peece d put so much in at the touch-hole, as will

will ſerve to drive out the ſhot. But w
a ruſty ſhot hath for a long time ſtuck f
within the peece, put ſtrong Vinegar
the mouth of the peece, and with the ra
mer ſtrike the ſhot till it do move, th
poure the Vinegar out again; if it ha
ſoaked through the powder, then prim
with a little freſh powder, and give fire;
the Vinegar could not paſſe by the ſhot a
mongſt the powder, then moiſten the fi
powder with ſome water or Vinegar; whe
it is yet dank and moiſt, prime the touch-
hole with good powder, and give fire.

CHAP. 51.

A merry conceit, how to charge a Peece of Ordnance without Gun-powder.

This may be done with air and wate
onely having put cold water in
the concavity of the peece, filli
one quarter of the Cylinder, put in after
a Tampion of wood as long as broad, per-
fectly made to fit the peece, with an oyle
cloath

cloath about it, doubled either more or leſs, that it might be two mens ſtrength to put it home, this done, put in the ſhot, elevate the peece a little, and make a fire under the hinder part thereof, the touch-hole being very cloſe ſtopped, then put the ſpunge of the peece in oyle, and wet all the Cylinder of the peece with oyle, that it may paſſe out the glibber: for when the fire hath ratified the water, it will burſt out ſuddenly. The experiment which we have in long Trunks ſhooting out pellats with aire onely proveth this alſo.

CHAP. 52.

A Peece of Ordnance at one ſelf-ſame elevation, and towards one ſelf-ſame place, with the like quantity of powder and ſhot, diſcharged ſeverall times, what ranges it will make.

I Have diſcharged a peeee ſeven times in the ſpace of 50 minutes, with the like weight of powder, ſhot, and elevation, and have found their ranges as following, the

the first shot was conveyed 416 paces, the second 436, the third 440, the fourth 434, the fifth 425, the sixth 410, the seventh 394, so that the greatest difference from the first shot, was 24 paces, these things must be kept in perfect memory, by every one that learneth to shoot at random, or he shall be never good at that practice. The reason of these things is this, at the first shot the bullet found the aire quiet, and at the second shoot it did not onely find the aire stirred with the first shoot, but also moving or tending towards the place at which it shot, and because it is more easie to move and penetrate that which is already moved and open than that which is close and quiet, it followeth that the second shot finding in his range a lesse resistance than the first did, will outfly the first.

A second reason is, at the first shot the powder being put in the peece, doth often times find the same somewhat moyst, especially when it hath not been shot in for certain dayes before, through which the powder will not fire quickly, as it doth when the peece is dry and temperately warm, for this warmth or heat will somewhat dry up

the

moysture which is in the powder, and make it to fire sooner; wherefore the powder doth not work so forcibly in the first shoot as it doth in the second, the third shoot and fourth will be much like the second; now I will give you the reason, why as the peece grows hotter, one shot will not out-shoot the shot before it, but every time come shorter and shorter.

The peece waxing hotter, and by how much the more hotter, by so much the more attractive is the concavity of the peece made, and because the shot is driven forth, or expelled with no other thing than by the airy exhalation, or wind caused through the sal-peter, therefore by making such a peece the more attractive with the more heat, which suppeth and receiveth continually more and more of that wind, which should serve to expell the bullet, the vertue expulsive in that peece, doth continually more and more decrease, and the shot flyeth not with that swiftnesse as it did before; although the two first things, that is, the breaking of the aire, and the drying of the powder every time more and more, doth help much the range of the shot, which aid and help, as it

is to be believed, that sometimes it supply-
eth and perchance gives advantage by the
expulsive vertue, which continually the
peece doth diminish, or sup in according as
it heateth, so that the third & fourth shoot
will not be much differing from the second
shoot, nevertheless, in continuance of time
the said two accidents (that is the opening of
the aire and drying the powder by the heat
of the peece) cannot supply the third acci-
dent, that is, the vertue attractive, by reason
the attraction is augmented as the peece
heateth: this caused my sixth and seventh
shoot to convey the bullet 22 paces shorter
than my first. It is reported by *Nicholas
Tartaglia*, that many shoots being made at
a battery by a peece, it chanced by some oc-
casion, that the peece rose up in such sort
that the mouth touched the ground; a little
dog passing by, did smell unto the peeces
mouth, and by so doing was fast joyned to
the peeces mouth, and immediately after
drawn into the said peece: which thing
when the standers by had seen, some of them
ran to help the said dog, and although they
found him to be drawn almost to the further
end of the concavity, they pulled him out
al-

st dead: This was done by the vertue ctive.

CHAP. 55.

How many Horses, Oxen or Men will serve to draw any Peece of Artillery

Or every hundred weight of metall, one man: so a Peece of 8000 pound weight, requires 80 men: besides so many more men as the carriage may weigh. erall hundreds, for every 500 of metall one horse, then 16 horses will draw a Gun of 8000 weight, but in the Winter 24, so 17 yoke of Oxen, is thought sufficient draw a Peece of 8000 weight, but in the inter they need to be one third part more.

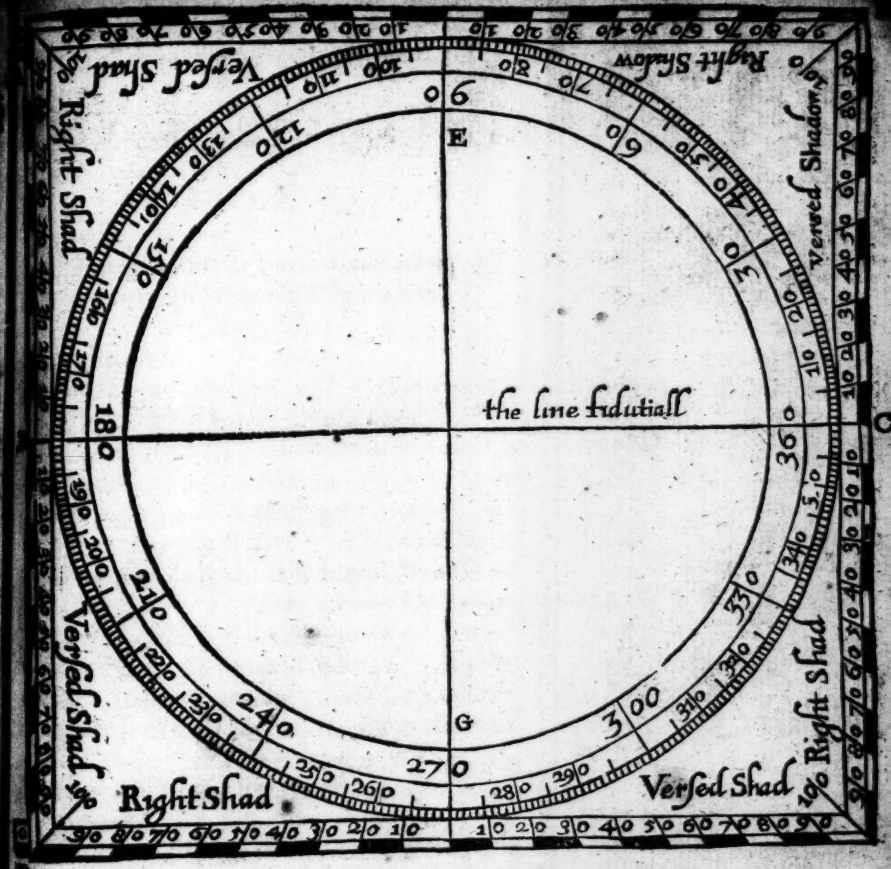
CHAP. 54.

A description of the Instrument wherewith the Reader must learn to take heights, depths, and distances.

THis Instrument is four square, with a Circle in the middle, divided into 360 degrees, the divisions on the squares, proceed from one, to ten, or from 10, or 100, the figure you may see before you: you may call this instrument a *Circumferenter*, or *Geometricall Square*.

Sometimes you must use an *Index*, and at other times a Line, and Plummet, according as I shall (in the ensuing Treatise) give directions.

CHAP.



Place the Instrument between 36 and 37, little c.

Place the Instrument between

CHAP. 55.

The use of this Instrument, to find the height of a Tower or Castle which is accessible.

FIrst, holding one side of your Square Parallel to the Horizon, move the Index upward, till thorow the Sights thereof, you perceive the top of the Tower, or Castle; then look what part is cut by the Index, upon the Square, if it be of Right Shadow, multiply the distance to the base or foot of the Tower by 100, and divide by the parts cut, adding thereunto the height of your eye from the ground, but if of contrary or vers'd shadow, multiply the distance from the middle of your foot by the parts cut, and divide by 100, not forgetting as well as before, to adde the height of your eye from the ground.

If you find it more convenienter to use the plumb line then the Index, doe thus, fix the line upon the pin on which the Index

did move, and make your observation through the sights on the side of your Instrument, marked with the letters A B, to the object you desire to know the aforesaid by, and the plummet line will cut the same division as the Index did formerly.

Suppose the Index or plumb-line cut the 35th. division of the Scale of versed shadow, in making my observation towards the Castle or Tower, and the distance thereunto be 135 yards, what will the heighth amount unto? because it is of Contrary or versed shadow; then, as you are taught before, multiply the distance from the middle of your legs to the base 135, by the parts cut 35, divide by 100, and the height will be found to amount to 75 yards and one quarter, above your eye, whose heighth as it shall be found must be added to the aforesaid number.

CHAP.

CHAP. 56.

How to find the height of any Tower that is inacceſsible.

IF you would take the Altitude of any Tower, Wall, Hill, or other Edifice which is unapproachable, either in regard of the enemy lying between, or of ſome Ditch, River, or other impediment, you ſhall proceed as followeth: firſt approach to the neareſt and moſt convenient place for your purpoſe, where with your Inſtrument make obſervation; and note down, or remember what parts are cut in the Scale, you muſt then goe back in a ſtraight line, according to the commodiouſneſſe of the place, and make a ſecond obſervation noting as before, the parts cut in the Square, which will be either on the Right and Verſed Shadow, if they fall both on the Verſed Shadow, (which moſt often doth happen) you ſhall divide the ſide of the Square ſeverally by the parts cut, and ſubſtract the leſſer

Quotient from the greater, and by the remainder, divide the distance between the two stations, to that adde the height of your eye from the Horizon, you have your desire.

Example.

Suppose the parts cut at the first station be 45 *(Versed Shadow) and at the second* 30, *(both Versed Shadow) I divide the whole side of the Square, which is* 100, *by these two Sums severally, and find the one to be contained* $2\frac{10}{45}$ *or in decimall parts thus,* 2|222 *the latter number is contained* $3\frac{1}{3}$ *or* 3|333, *by the difference I divide the distance of the stations, substract* 2|222 *out of* 3|333, *the difference will be* 1|111, *the Distance* 24 *yards, being thereby divided, the product will be* 22|22, *the height of mine eye* 5 *foot, these added will give the height,* 22 *yards,* 2 *foot, and* 2 *inches almost, of the said object.*

CHAP.

CHAP. 17.

How to perform the ſame operation when the parts cut fall on the Right Shadow.

WHen the parts cut in each ſtation be of right Shadow (which is very ſeldome) ſubſtract the leſſer number of thoſe from the greater, and put that in the firſt place: in *The Golden Rule*, or *Rule of Three*, the ſide of the Square in the ſecond place, and the ſtationary diſtance in the third.

Example.

Let the parts cut in the firſt ſtation be 30, *in the ſecond* 40, *of right ſhadow, ſubſtract the leſſer from the greater, the remainder is* 10, *the which ſhall be put in the firſt place of the golden Rule, the ſide of the Square being* 100, *in the ſecond, and the diſtance between the*

the two ſtations ſeven, in the third place, ſ
the Rule ſtandeth thus: As the difference o
parts cut is to the whole ſide, ſo is the diff
rence of ſtations to the height required; Or,
as 10 to 100, ſo 7 to 70 the height.

CHAP. 58.

How to take an Altitude at a place unapproachable, when the parts cut are of different Shadows.

IF the parts cut in the neareſt ſtation be of right Shadow, and the furtheſt be of Contrary Shadow, they ſhall be both reduced to one Shadow, after this manner; ſquare the whole ſide which is 100, and divide the product by the parts cut of the verſed Shadow, and the Quotient will give the right Shadow: that being done, ſubſtract the leſſer Shadow from the greater, and the remainder will be the firſt place in the Rule of Three, the diſtance between the two ſtations ſhall be the ſecond, and the ſide of the Square the third,

Ex-

Example.

Let the parts of Right and Verſed Shadow be both 30, *I deſire to bring them to be both right: Firſt, I ſquare the whole ſide which here is* 100, *it maketh* 10000, *that Product I divide by the parts cut of Verſed Shadow, which is* 30, *the Quotient is* 333, *and one third part; from whence ſubſtract* 30 *the right ſhadow, out of* 333 *and one third, the remainder is* 303 *and one third, for my firſt Terme, the diſtance between my two ſtations* 13, *for the ſecond, and the ſide of the Square* 100, *for the third. The Rule ſtandeth thus, As* 303 *and one third, is to* 13, *ſo* 100 *is to* 4 *yards and* 8 *Inches.*

To take the height of a Tower or Caſtle ſtanding on a hill.

To perform this, you muſt firſt take the height of the hill at two ſtations, as of a thing unacceſſible; and after the ſame manner, Take the height of the Hill and Tower together, which being done, ſubſtract the height

height of the ſaid Hill from the whole, the remainder will be the height of the Tower

CHAP. 59.

How to find the Longitude or Diſtance to any place by the Square.

I Deſire to know the Diſtance to a Tower in the wall of a City; becauſe of placing my Ordnance to diſmount a Gun upon the ſame, I make choyce of a convenient place for my ſtation, where placing mine Inſtrument, I bring the Index to the point C, to lye juſt upon the line D C written in the figure, *The Line Fiducial*, becauſe from this line proceeds the beginning of the degrees in the Circle, and it is moſt uſed, the Index being on this Line move the Inſtrument till you perceive through the Sights the Tower: letting the Inſtrument reſt firme, turn the Index directly upon the other line marked with E G. Look through the Sights, and if you can eſpie any place or thing, that you can

member to find exactly, take that for your second ſtation, if you cannot eſpy wherewithall to remember, cauſe one to go towards ſuch a place, that you can ſee through the Sights, with a handkirchief in his hand, when you eſpy that, bid him ſtop upon the ground, and goe to that place, there ſet up your Inſtrument, and laying the ruler upon *The Fiduciall line*, turn the Inſtrument untill you can eſpy through the Sights your firſt ſtation, then letting the Inſtrument ſtand ſtirme, turn the Index untill you can likwiſe eſpy the Tower through the Sights, and mark diligently what part cuts in the Square, then: As the parts cut are to 100 (the Radix) ſo the diſtance between the two ſtations, is as the Diſtance required.

Example.

Suppoſe the parts cut were 5, *the diſtance between the two ſtations* 30 *paces, then as* 5 *is to* 100, *ſo is* 30 *to* 600 *paces, the true diſtance to the Tower.*

CHAP.

CHAP. 60.

How to take the distance of divers places at one time, by help of the Circle that is described within the Instrument.

FIrst of all, find some convenient place in which set up your Instrument for your first station, and laying the Index upon the fiduciall line, turn the Instrument with the Index upon the aforesaid line, untill you see such a place as you think most convenient, (for in this you may choose your second station, which by the practice in the last *Chapter* you could not doe.) The Instrument thus fixed, espie through the holes every one of those places whose distance you would know, and write them down. I mean the degrees cut in the Circle, with the name of the place, always remembring to begin so far on the left hand as you have any mark that way; when you have noted them all down according as I have

have taught; goe to the second station, and place your Instrument there, lay the Index upon the fiduciall line, and look back to the first station, and espie it through the holes, after this, be sure your Instrument be not moved, then turn the Index to the first mark you took at the first station, and after observation made, note it down, as at the first time; when you have observed all the marks, take your Instrument away, goe to a large Table, and with your Ruler draw a straight line, acrosse the Table, Parallel to the Table end, and about two foot one from another describe two Circles; the former made line being a diameter to each Circle. First, divide the distance between the centers of the two Circles into so many equall parts, as there were paces between your two stations, then divide the Circles. In each Center fix a needle, and tie to each needle so many silk thrids as you had marks, extend each of these at a great length, just cutting the degree in the Circle that was cut in the Circle of the Instrument, when you made your Instrument all observation, beginning first with the first mark, so proceed, and the end of every thrid which

must

must be very long, fasten to the Table with a little soft wax, when you have fastened all the threds thus, that are on the first needle which signifieth the first station, place those on the second needle as you did the other with wax at their full extent, just over the Degree in the Circle, made on the Table as you have noted was made upon your Instrument by observation, beginning with the first as you did before, and so likewise fasten them. Now to know the distance to their marks, look where the first string of the Circle crosseth the first of the other, that place note for the first mark; look where the second crosseth with the second, that note for the second mark; so likewise, for the third, fourth, &c. till you have noted all the marks down, then with a pair of Compasses measure the distance unto each mark in paces or yards, according as the Scale between the Circles is divided, and what distance you find to be, either between one mark and another, or between the stations and the marks, is the true distance between those marks, or between either of your stations and marks, in paces, yards, or feet, according to the division of

Scale, but if the first, second or third &c. in one Circle, doe not tend to the same marks that you have noted in the servation, as the first, second, and third in the other Circle, then you are to the mark where two thirds crosse that tend to the same marks.

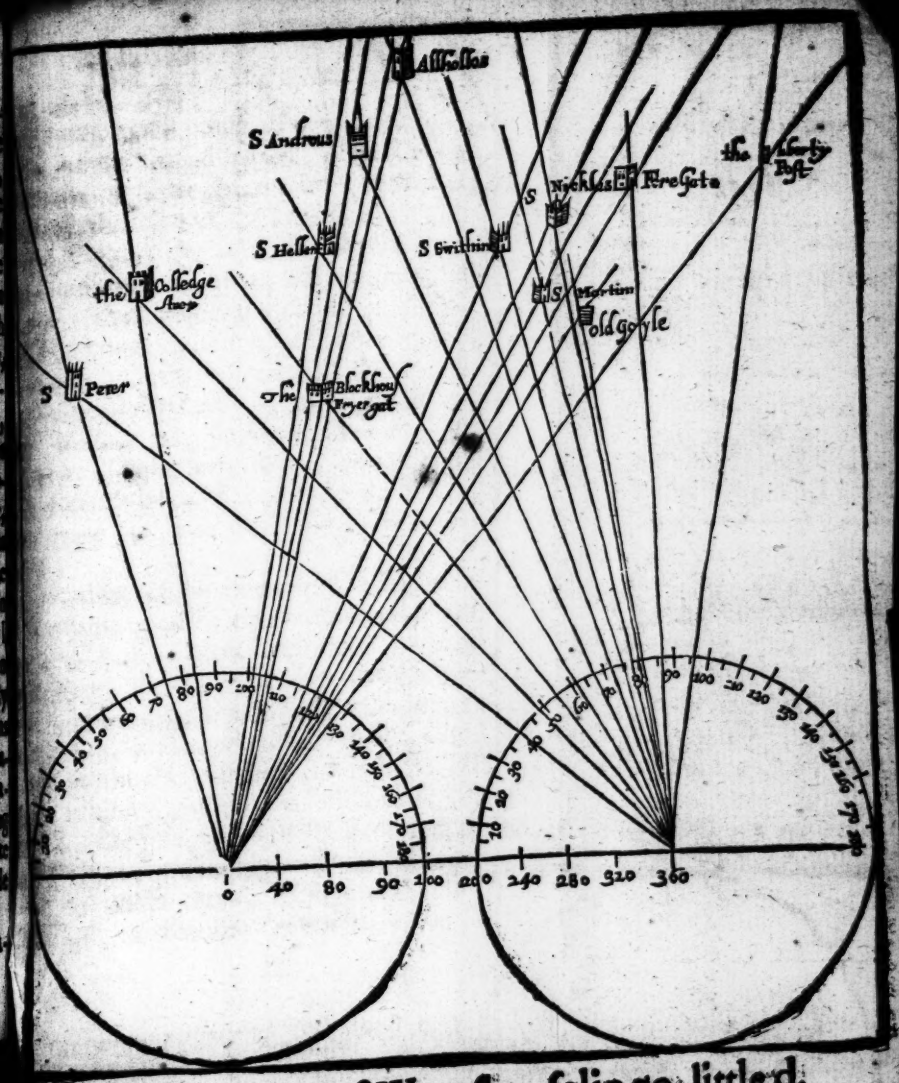
An Example to clear and manifest the last Proposition.

At such time as the Leaguer was before City of *worcester*, I took the distance such means as I have fore-taught, to e- remarkable place therein, by the afore- Instrument.

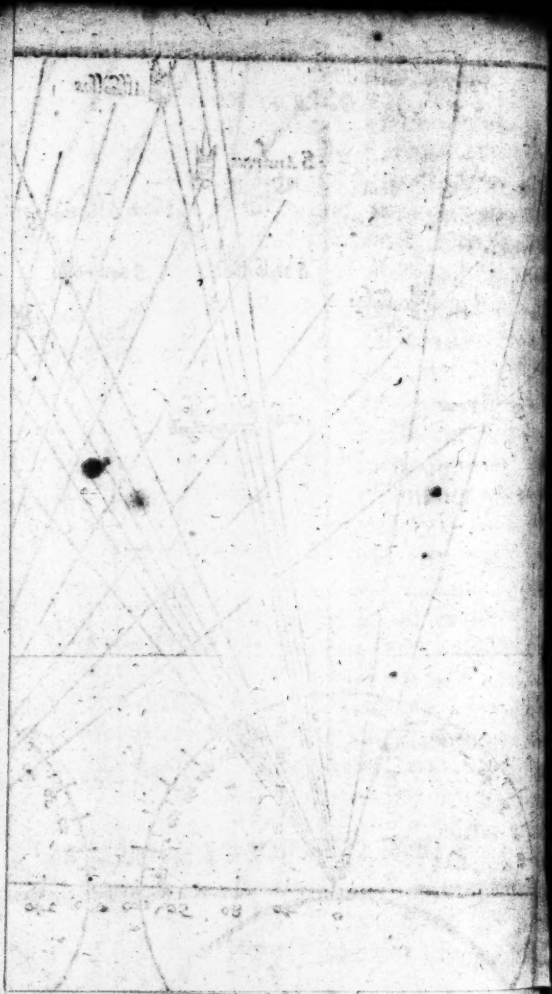
First, finding a convenient place for the station, and placing the Index upon the *diall line*, I marked where to make a se- station: the Instrument standing im- veable: The first and fartheſt mark to- rds the left, as I observed, was Saint *Pe-* Steeple, the Index cutting 75 *degrees*, next observation was made at the Col- ge Steeple, the Index cut 84 *degrees*, en Saint *Hellens*, the parts cut in that ob-

ſervation 102, my fourth mark was the loft
ty Spire of Saint *Andrews*, 104 *degrees*, th
fifth mark was the new built Block-houſe,
where formerly ſtood the Fryers gate, th
degrees cut were 106, the ſixth obſervatio
was made towards the high Towre Steepl
of *All Saints*, the Index cut 107 *degrees* i
the Circle, the ſeventh object was the eight
ſquare Towre Steeple of Saint *Swithins*
117, the eighth which was worth obſervā-
tion was the brick Steeple of Saint *Nicholas*,
where the Index cut juſt 120 *degrees*, th
ninth obſervation which I made was to-
wards Saint *Martins* free-ſtone Steeple,
where 122 *degrees* were cut, the tenth w
made towards the Fore-gate, called of ſom
the North-gate, becauſe of its ſituatio
North, here the degrees were 124, then
placed my Index upon or towards a rot
Towre in the walls of the City, ignorantly
called the old *Gaole*, upon which a Gun w
then placed, the degrees cut in this obſerva-
tion were 126, my twelfth and laſt obſerva-
tion was towards the liberty poſt ſtanding
amongſt the deſolate ruines of Fore-gate
ſtreet, where the Index cut in the Circle
128 *degrees*.

Ha-



Place the plot of *Worcester*, folio 50, litter d.



Having noted down all the aforesaid, I went to the second station, placed my instrument right for observation (by looking through the lights of the Index, it lying upon the fiduciall line to the first station) I began as before to make my observations, first of all at those places which lay farthest on the left hand, and so proceeded orderly to the right. Saint *Peters* cut 40 *degrees*, the Colledge Steeple 48, the Block-house 55, Saint *Hellens* 61, Saint *Andrews* 67, *All Saints* 72, Saint *Swithins* 75, Saint *Martins* 78, Saint *Nicholas* 80, the old Gaole, 81, Fore-gate 86, and the liberty post 95 *degrees*.

The distance between the two stations is 60 paces: upon a Table board I made two Circles, and divided them into 360 parts, or *degrees*, or onely the upper halves into 180 *degrees*, I placed two needles in each center one, and upon each 12 thrids, first I extended the thrids in the Circles in the left hand, which signifieth the first station, just over such degrees which were cut at time of observation, proceeding orderly, the first thrid for Saint *Peters*, the second for the Colledge, the third for Saint *Hellens*, &c.

When you have placed all the thrids which are on the first Needle, doe the like with the thrids upon the second Needle, beginning first towards the left hand with Saint *Peters*, next the Colledge, the third the Block-house, the fourth Saint *Hellens*, the fifth Saint *Andrews*, &c. all the thrids being placed, look where the thrid of the same mark in both instruments crosse one another, just there make a prick for the mark: as for example, the thrid of the Block house is the fifth in the first Circle, and the thrid in the second, where these two crosse, is the Block-house, measure with the compasses according to the Scale, between the center of each Circle, and you shall find the said Block-house to be distant from the first station 400 paces, from the second 474 paces, from Saint *Peters* 197 paces, from Saint *Andrews* 203, from the Fore-gate 304 and from the liberty Post about 400.

The distance between *All Saints* Steeple and the first Station is 680 paces, between it and Saint *Andrews* it is 35, from Saint *Peters* 273, and from the Fore-gate 202.

Saint *Andrews* is distant from the first station 610, from Saint *Martins* 192, from Saint

saint *Swithins* 142, and from the Colledge 113: Thus you by the Scale and Compasses may find the distance to and between any of them.

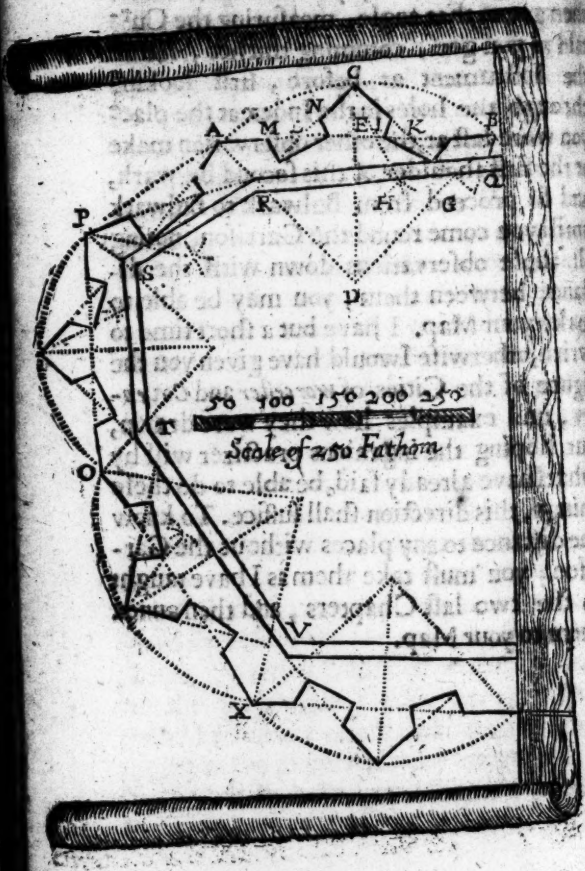
CHAP. 61.

How by the aforesaid Instrument, to draw the Plot of a City or other Garrison, and to take the distance to every remarkable Object within Cannon shot.

IT behoveth every Master Gunner, of a Town, Castle, or other Fort, to draw a description of his said Garrison, and of every notable object within Cannon shot, for he having a Map of all these things, need not be troubled to take the distance every time he hath occasion to shoot at the enemy, for by his Map and the objects without the Garrison therein described, he may be able to estimate how far or near the enemy doth reside. To make a description of the Gar-

riſon, he is to do thus, ſet up his Inſtrument firſt upon the ſhoulder of the Bulwark, and obſerve the angle thereof, by placing his Index firſt upon the *Fiduciall line*, and moving the Square untill you may perceive the Flanker, then letting the Inſtrument remain fixed, turn the Index till you can ſee the Diamond point through the holes, the Degree cut is the angle of that ſhoulder, with a chain or line, meaſure the diſtance to the point of the Bulwark, and meaſure that Angle as you did the former, by eſpying through the Sights (the Ruler or Index lying upon the *Fuiduciall line*) the place where you ſtood laſt on the ſhoulder, from the Diamond point meaſure the diſtance to the ſecond ſtation, and obſerve the angle of that as before is taught; firſt, by looking back through the ſights, the Index lying upon the *Fiduciall line* to the Diamond point, then turning the Index, look to the angle at the flank, note as before the degrees of the Angle: Then departing from that place, meaſure to the angle of the Flank, there alſo ſet up your Inſtrument, firſt looking through the ſights at the place you were laſt at, turn the Index and look ſtraight along the Curtain,

to the angle where it joyneth with the Flank, then goe to that angle, measuring the Curtain as you goe, comming thither, set up the Instrument as before, first looking through the holes in the Index at the place you were last at, the other observation make at the first shoulder of this second Bulwark, and so proceed from Bulwark to Bulwark untill you come round the Garrison, noting all those observations down with the distance between them, you may be able to make your Map. I have but a short time to write, otherwise I would have given you the figure of the Cities of *Worcester* and *Coventry*, and examples how they were drawn, but hoping the ingenious practizer will by what I have already said, be able to do these things, this direction shall suffice. To know the distance to any places without the Garrison, you must take them as I have taught in the two last Chapters, and then annex them to your Map.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A TREATISE OF Artificiall FIRE-WORKS for War and Recreation.

Conteining a deſcription to make ſundry kinds of FIRE-WORKS both for uſe and pleaſure, with leſſe labour and coſt than any hath heretofore been publiſhed.

All of them being experimented and practiſed by the Author, as alſo compared to the beſt, which are taught by any other Author whatſoever.

By *Nathanael Nye.*

London, Printed for *William Leak*, at the ſign of the *Crown* in *Fleetſtreet*, 1670.

A TREATISE OF Artificiall *Fire-Works* for the Wars.

CHAP. I.

A description of the Mortar-peece, and how to make one of Wood and Pastboard for a need, these of Brasse and Iron being wanting.

THe best Mortar-peeces are made of the same metall that brasse Ordnance are made of, and being to be made, let the measures following be observed,

ved. If the Diameter or bore be nine inches, let the mortar be one foot and a half in length, and let the chamber in which you load your peece with powder be three inches diameter, and four inches and a half deep, the thicknesse of the metall about the touch-hole three inches, and the upper part thereof one inch and a quarter.

How to make the Mortar-peece of Wood and Pastboard.

You must get a woodden rouler of such bigneſse as you desire to make the diameter of the Mortar, and upon that rouler let pastboards and canvas, with good store of molten glue, rouled (remembring to anoint the rouler with greaſe, or otherwise the glue will cause that you cannot take the pastboards off again) which done, let the canvals and pestboards dry a little while on the rouler, another while off from the rouler, and when this kind of trunk is very dry, put it on the rouler, and set it in a lathe, and cut off both ends of the trunk with a Chisell

very

very even, taking this out of the lathe, turn a foot thereunto, with a ſhoulder to put the trunk upon, and in the middle thereof make the chamber for the powder, if the peece be eight inches in the mouth, let the thickneſs of the paſtboard trunk be two inches thick, and 18 inches long, the britch or foot be 10, the ſhoulder two inches long and two inches high, that when the trunk is put on this ſhoulder, and joyned with the wood, it may be juſt even with the ſame, the bore into which you put your powder muſt be two inches high and three deep, plated with copper or lattin, if it be poſſible, as alſo all the face of the wood that goeth into the trunk; when you have put the trunk upon the britch of wood, naile it round about the ſhoulder, firſt making holes with a bodkin through the paſtbords, and then driving in the nails upon that wood which you made to receive the paſtbords or trunks on, being cut lower than the reſt by two inches, the thickneſſe of the trunk, becauſe when it was put on, it might be levell with the reſt of the britch, theſe things done, cover both wood and trunk with cord and glue again, which being well dryed will laſt

a long time, I have ſuch a one of this making, wherewith I uſe to ſhoot *Balloons* into the aire, for my recreation.

There is a very honeſt man in the Market Town of Bromſgrove, *named* John Tilt, *who can make either Mortar-peeces or Ordnance, with Tin, Wire, Paſtboard, and Glue, of excellent durance and ſervice, if not wronged in the charge or loading of them.*

CHAP. 2.

How to fit and prepare Granadoes for the Mortar-peece.

MOſt commonly the ſhot for great Mortar-peeces are one tenth part lower than the bore, becauſe of cording them to ſling into the mouth of the peece, and for fear of ſecret cracks, that cannot eaſily be eſpyed, they are coated with pitch, ſo that being prepared, they do but juſt fit the bore.

How

How to make Fuſes.

Every Ball hath a hole, left to put in a Fuſe or piece of wood juſt like a Faucet for a ſpigot, this hole muſt be one quarter the diameter of the woodden Fuſe, which Fuſe muſt be in length three quarters the height of the Granade, made taper, and when filled with compoſition driven gently in amongſt the powder that is in the ball, leaving a little of it without: the compoſition for this Fuſe is made thus: take one pound of Powder, four ounces of Salt-peter, and one of Brimſtone, firſt beaten to powder, and ſifted in a ſerce ſeverally; theſe ingredients being mixed together, your compoſition is made fit for uſe.

CHAP. 3.

The manner how to make Granadoes of Canvas for the Mortar.

THe operation of theſe Granadoes made of canvas, is quite contrary to thoſe already ſet down, theſe are onely

onely fit to fire a Town, they are not of so violent execution as the precedent yet altogether as costly in the making; for the making of them fill a peece of canvas upon a round ball of wood, so big as you would have your *Granadoe*. Then make this composition following, four pound of Salt-peeter, two pound of Gun-powder dust, and two pound of Brimstone: all these incorporated and moistned with oyl of Salt-peeter, fill your case with this compound, and cover it with cords, which done pierc the sack full of holes with a good bodkin, and in every hole place a little Iron barrel, charged like a Pistol: these must be driven into the sack up to the head, the *Granadoe* being thus prepared, let there be made a hole about one inch deep, which shall serve to prime it with powder-dust, moystned with oyl of Petroll; you may make all those barrels of old musket barrels, or of other pieces either little or bigger, onely leave wide touch-holes, to the end the rust stop them not, so they may be preserved many years; and ready for service at all occasions.

CHAP.

CHAP. 4.

How to make fiery Arrows or Darts.

GEt a long ſhaft of wood; and joyne unto it an iron head, after the manner of the figure in the margent; and about the middle of that head make firſt a linnen bag, in form of an Egg, leaving open

at the end before a hole, that it may be fitted with the compoſition following. Take one pound of Peter, half a pound of Gunpowder, and as much Brimſtone in powder, all theſe ingredients being well mixed, and mingled with oyle of Petrioll: with theſe fill the bag round about the arrow head: then let all be bound about with wire, and for the priming of theſe, dip Cotton-week into Gunpowder wet with water, let the Cotton be well dried again before it be applyed. Now for the joyning of your wooden ſhaft to the arrow head, it ought to be done ſo ſlightly, that being faſtned into any thing, thoſe may be deceived, and pull it onely away, & to hinder that one may not pluck out the head with their hands there may be made a ſmall hole quite thorow backwards, and ſo a man will be prevented in aſſaying to pull it off, although it ſtick in his fellows clothes.

CHAP.

CHAP. 5.

How Granadoes are to be charged in the Mortar.

THere ought to be great care taken in the loading or charging of the Mortar, which must be done thus. First, weigh the powder to a dram, that you put in the Chamber; and after it put a good close wad of hey (for to my knowledge and deep experience it is very uncertain shooting y u using in stead of hey, a tampion of wood) which done cut up a turff of the ground, that may fill the bottom of the bole, or bore, of the Mortar, next the wad: your *Granadoe* being prepared, as is before ught, with a coat of pitch and chord, fling it into the mouth of the Mortar; observing to have the Fuse of the *Granadoe* in the middle of the bore: then go to the breech, thrust up a wire into the touch-hole, to make all sure, then prime with speciall dry powder, such as you

are ſure will take fire, this being the whole buſineſs in which your life and Mortar-peece both ſtand in jeopardy: I will give you very ſure directions to give fire.

Provide ſmall Fuſes, ſuch as I taught you to make before for the ſhels, but a great deal leſſe, about one quarter of an inch bore, three quarters in thickneſs, and eight inches long: fill theſe with good powder duſt, moiſtned with oyle of *Salt-peter*, you muſt moiſten it but a little, and put it in with an iron rammer, try whether you like the time they continue burning; if too ſlow, abate oyle of *Peter*, if otherwiſe, adde it thereunto.

Theſe being made ready, the uſe of them is thus: thruſt the pike of your Linſtock in at one end of the Fuſe you mean to give fire withall, bid one of your aſſiſtants come on one ſide of the mouth of the peece, and give fire to your Fuſe, wherewith fire the Fuſe in the Mortar, and then with great ſpeed give fire to the touch-hole.

Theſe Fuſes are very certain to give fire, but match doth oft times faile.

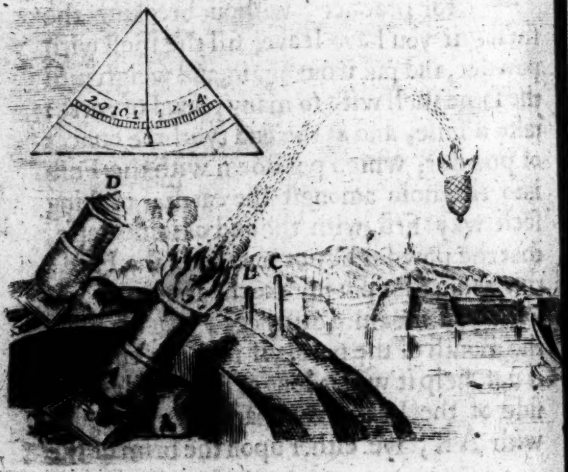
CHAP.

CHAP. 6.

How to levell the Mortar-peece, to make an effectuall shot at any assigned mark.

YOu are to get leave of your Superiours to try one, two, or three shoots for practice, without breaking the shell; if you have leave, fill the shell with powder, and put it out again, and weigh it: fil the same shell with so many pound of earth: take a Fuse, and at the end tye three ounces of powder; which put down with the Fuse into the hole amongst the earth; making such way first with the end of some staffe, that the powder be not torn from the Fuse; this being thus put in, take the square wherewith you measure distances, place it upon the mouth of the peece, if it be big enough, if not, help it with a longer Ruler, let that side of the Instrument marked in its figure with AK, lye either upon the brim of the

Peece, if it will reach; if not upon the rule, take off the Index and hang on the plummet, ever observing to mount your Peece above 45 degrees, then elevate the Peece at what random you please, noting it down; then make your shot, getting those that stand by to go and observe whether the Fuse burn all the while of the *Granadoes* flight; and when the three ounces of powder take fire: for hereby you may mend the Fuse, and try



whether it will keep fire; these things observed, measure that distance, and place it in your note, under the degree you mounted by, as also the weight in powder the Mortar used. When you by two or three shoots have gathered experience, both of your fuse, and of the true range of your Peece; take the distance to the Town, Fort, or other mark you are to shoot at; then to know at what degree to mount the Mortar-Peece do thus, by the *Rule of Proportion Reverse*, as the distance (when you made your tryall) is to the degrees cut, so the distance to your assigned mark, is to such a degree of the Circle that you must mount your Peece unto: To make it more easie, I will give you an *Example*.

Suppose, that you made your experimentall shot at 46 degrees, and your ball ranged 320 paces, how many more degrees must you mount the Mortar to shoot 280 paces: that being the distance to your assigned mark: multiply 320 by 46, and there ariseth 14720, which divide by 280, you shall have 52 degrees, and above half one, to which you must mount, to reach the appointed place.

Note, that if you are to play a Mortar-peece a long time againſt a Fort, you are to ſeize upon a barrel of the beſt powder in the Magazine, and keep it for your uſe; alſo go into ſome place free from fire and ſtir this powder, that in caſe one end be weaker than the other, you may mend that defect: for I do aſſure you, that if you change your powder, you have loſt all your experience, and are as new to begin again, as at the firſt time; alſo beware of uſing tampions, let one man conſtantly put in the wad, giving him charge to make the like wad, and uſe the ſame ſtrength, ſo near as he can, which he did before; waſh every one of your ſhels before you coat or put the chord upon them; when you have made them clean, put a little powder into one of them, and give fire to it with a match, then ſuddenly clap a clot of clay upon the hole; then obſerve diligently whether any ſmoke come out on the ſides; if it do, then that muſt be very carefully coated, or not uſed, but thoſe that vent no ſmoke you may truſt to be good ones.

Another obſervation I will tell you of, that is, you muſt by the help of a great paire of Scales weigh every ſhot, and make them

them all even of a weight, by putting thereinto ſo many Muſquet bullers as will make them even, this being done, fill that which is heavieſt, (for without doubt that will contain leaſt powder) put the powder out again, and weigh that powder; ſuch a quantity, and no more, fill all your *Granadoes* withall.

CHAP. 7.

How to make Granadoes to caſt with mens hands.

HAving taught how to make *Granadoes* for the Mortar-peece, and that in an eaſier & plainer way than any ever before me hath done to my knowledg. I will ſhew how to prepare ſome ſmall *Granadoes* for the hand, the effects whereof are of no leſs eſteem than the other chiefly in aſſaults; whether it be for the offendants or of defendants; Firſt of all fill theſe ſmall ſhels with fine Gunpowder, then make a Fuſe of

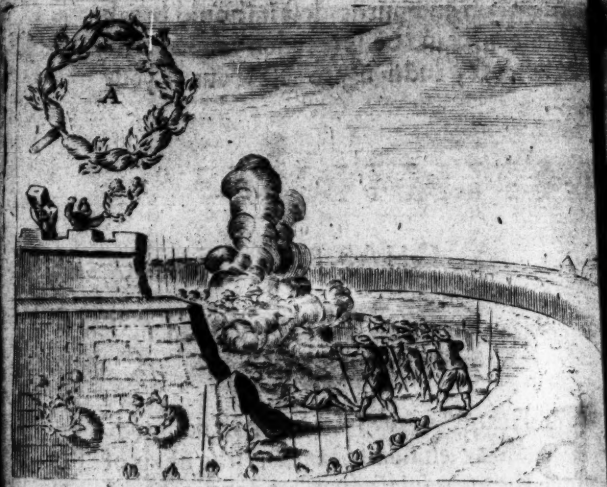
one pound of Gunpowder, ſix ounces of Salt-peter, and one of Charcole, or if you would have them of leſs durance, you may take of the compoſition made for the Fuſes of great *Granadoes*, knock the Fuſe up to the head within one quarter of an inch: which is onely to find it by in the night, ſtop well the reſt of the hole in the *Granado*, (if any chinks are open) with ſoft wax: then coat it

with pitch and hurds, leſt it ſhould break in the fall, and be ſure when you have fired the Fuſe, ſuddenly to caſt it out of your hand.

CHAP. 8.

How to make fiery Wheels, to be caſt with mens hands.

BEcauſe every ſouldier will not meddle with hand *Granadoes*, the uſing of them being ſomewhat dangerous, I will here teach another kind of Fire-works which is little leſs offenſive, for the making thereof, you are to uſe theſe ingredients: Take four pound of Gunpowder in duſt, one pound of Charcole duſt, two pound of Tar, two of Salt-peter, and one pound of Roſin; all theſe ingredients being well incorporated, and heat over the fire, ſteep tow or flax in the ſame, and then wrap the tow and flax about a hoop, and then cover all this again with Gunpowder duſt; and in time of need



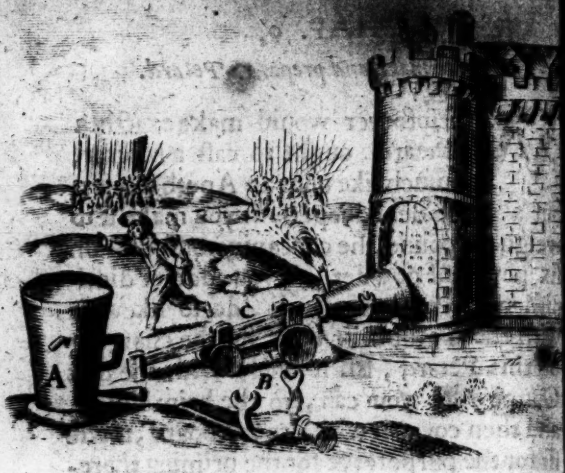
need give fire to them, & caſt them amongſt your enemies, this is to be obſerved, that the hoops ought not to be too large, but falling upon a many ſouldiers they may there ſtay and ſtick; and to make them more troubleſome, and entangling, two of them may be tyed a-croſſe one another; and then falling upon any man he cannot chooſe but be much aſtoniſhed with ſuch a fearfull element, and put his company in great diſorder.

CHAP.

CHAP. 9.

How to make and prepare a Petard.

WHoſoever would make exactly a Petard, ought to caſt a Mortar, much like unto an Apothecaries; but a great deal deeper; if you make it to weigh 36 pound, the concavity muſt contain ix pound of powder, if you adde or diminiſh more or leſs metall, do ſo likewiſe with the Calliber or bore, for the charging of this Petard, fill it onely with the beſt Gunpowder you can, to the brim almoſt, and then cover it with a round board, made fit for the purpoſe, & for the priming thereof make a Pot-fire, or Fuſe of ſlow compoſition, of what length you pleaſe; this muſt be put down a hole in the middle of the cover of wood, a good way into the powder, if the Peece have no touch-hole, and cloſe waxed about that no ſpark of fire ſhould get in, and the Petard is prepared; to break open the place you deſire, if it be acceſſible, then with the breech of the Petard, upon the ground, or ſome great ſtone, or piece of



of wood, and the mouth againſt the part of the door or gate, but if the place be unacceſſible, then make a little Cart with two, or four wheels, and ſo ſupport the recoyle of the Petard, ſhooting off: The Petard muſt be made faſt to a long beams end, that muſt go a-croſſe the ditch or moat, the reſt of the beam or heavieſt part thereof reſting upon the Wheels, able to counterpoize the other part

art thereof together with the Petard : and is prepared for to make a breach in a slender wall, or door, or gate unaccessible.

CHAP. 10.

Of Artificiall Fire-works for Recreation and delight.

How to make Rackets for the Aire.

I Will not teach how to make Moulds, Needles, &c. for such men as are curious in these things, let them buy Master *Bate*, Master *Babington*, or for a need Master *Malthus* Fire-works: that which I will onely do shall be to teach to make them without Moulds, or any other thing than a rouler to roul the paper upon: for such I use to make, having all other devises that are taught by the aforsaid learned men, but make little use of them; to make Rackets my way do thus, cause a Rouler to be turned in a lathe, what thickness you please: onely let the rouler be 8 times the diameter therof in length, if it be three

three quarters of an inch in thickneſs, the length will be three inches, roule your paper hard on the rouler, till it make an inch and one quarter the whole thickneſs, rouler and all, then glue the uppermoſt paper, and the caſe is made, onely choaking or contracting the paper together, (within one diameter of the bore of the end) except one little hole, about one quarter the Diameter of the bore thereof: to contract theſe caſes on this manner, do thus, wet the end about one inch in water, then put the rouler in again, and tye a great packthrid about the wet, within three quarters of an inch of the end; put another thing almoſt of the ſame diameter of the rouler in at the wet end about half an inch, hold it there, get ſome other body to draw the packthrid together, you holding the rouler and rammer, one put down to the end within one inch, and the rammer which muſt be a little leſs in diameter, to meet with that end withinhalf an inch, in which place the contract or choking muſt be; the packthrid having drawn it together, tye it faſt on that place, take out the former, let it dry and it is done: when the hole is contracted together, make it ſo wide, as is

before

before taught, with a round Bodkin, which you muſt provide for that purpoſe.

A The mouth of the Racket. B ſo far muſt the Bodkin be thruſt up the middle. You muſt have a ſmaller Bodkin (which when your Rackets are filled with compoſition, and tyed to the rod) you muſt thruſt this Bodkin in at the mouth, ſtraight up to the midſt of the Racket, having a care of thruſting it nearer one ſide than the other.

CHAP. II.

How to make the Compoſition for Rackets of any Size.

THeſe wayes which I will teach you, I take them not upon truſt out of Authors to that purpoſe, but have experimented what I teach; and firſt for Rackets of one ounce, you muſt uſe onely Cannon-powder duſt, being beaten in a mortar and finely ſearſed, which riſeth very ſwift, making a great noiſe, but carries no tail: thoſe of moſt beauty in their operation are made, with putting one ounce of charcole duſt to eight ounces of powder, this compoſition will hold for Rackets of one, two, and three ounces; but for thoſe of four, take three ounces of charcole to one pound of Cannon-powder duſt; continuing that rule, untill you come to Rackets of ten ounces, and from thence to Rackets of a pound, one pound powder duſt, and four ounces

ounces of charcole-duſt: bigger than theſe I have no experience of.

To fill the Rackets with this Compoſition.

Place the mouth downwards where it was choaked, & with a knife put in ſo much as you can of the receits, provided for that ſize at one time, then put down your rammer, which muſt be longer and narrower than the former or Rouler upon which you made the caſes, and with a hammer of a pound weight give three or four indifferent knocks, then put in more compoſition with your knife, untill it be full, at every time knocking the like as before, with the rammer, untill the compoſition come within one diameter of the bore of the top, there put down a peece of paſtbord, and knock it in hard, prick three or four little holes therein, then put fine piſtoll powder in almoſt to the top, and upon that another cap of paper, upon which put a peece of leather, that it may be tyed on the top of the Racket, and faſt glued on, then get a ſtreight twigge, and bind it upon the Racket with ſtrong packthrid,

thrid, it must be no heavier, then being put upon your finger, two or three fingers bredths from the mouth of the same, it may just ballast the Racket; then it is prepared for use.

CHAP. 12.

How to give fire to one or more Rackets.

SEt your Rackets mouth upon the edge of any piece of timber, battlement of a wall, top of the Gunners carriage wheele, or any dry place whatsoever, where the rod or twigge may hang perpendicular from it, then lay a train of powder that may come under rhe mouth thereof, give fire thereunto and you have done. But if you would fire more Rackets than one, that as one descendeth the other may ascend by degrees, make this composition following, of *Roch peter* 8 ounces, *Quick Brimstone* 4 ounces, and fine Powder dust 2 ounces, which lay in a line from one Racket to another, they being placed ten inches or a foot

one

ne from another; give fire to this compoſi-ion, and it will work your deſire, by cau-ing one to mount into the aire when the o-her is ſpent, but before you place your Rackets, remember to prick them with the odkin, as I have taught you in the tenth Chapter, at the latter end thereof.

CHAP. 13.

Divers and ſundry Compoſitions for Stars.

A compoſition for Stars of a blew colour mix-ed with red.

Take of *Powder mealed,*	8	ounces.
Saltpeter,	4	
Quick Brimſtone.	12	

Meal all theſe very fine, and mix them to-gether with two ounces of *Aquavitæ*, and half an ounce of oyle of *Spike*, which let be very dry before you uſe it.

Another compoſition which maketh a white and beautifull fire.

Take *Powder*,	8	Ounces.
Salt-peter,	24	
Quick-Brimſtone,	12	
Camphire,	1	

Meal theſe ingredients and incorporate them: Now to meal your *Camphire*, take a braſſe peſtle and mortar, wet the end of the peſtle in a little of the oyl of Almonds, and it will meal to powder, then keep it cloſe from the ayre, elſe it will become of no uſe.

Another white fire which laſteth long.

Take *Powder*,	4	Ounces.
Salt-peter,	16	
Brimſtone,	8	
Camphire,	1	
Oyl of Peter.	2	

Meal thoſe that are to be mealed, and mix them according to the former directions.

CHAP.

CHAP. 14.

The manner of making Stars; and to use them.

TAke litle four-squar pieces of brown paper, which fill with the composition you approve of best, of the three last taught: so double it down rouling it untill you make it round, about the bigness of a nut, or bigger, according to the size of your Racket, that you intend them for, prime them, with drawing thorow them Cotton-week, and they are prepared

You may also make them after this manner; you must have a rouler which must be as big as an ordinary arrow, which shall be to roul a length of paper about it, and with a little glue paste it round; when it is dry draw out the rouler, and fill it by little and little, with a thimble: still thrusting it down, every filling of a thimble, with the rouler; which being filled cut it in short pieces, about half an inch long, then having in readi-

neſſe either hot glue, or ſize, wingled with red lead; dip therein one end of your ſhort peeces, leſt they take fire at both ends together; and becauſe that it may not ſo eaſily blow out, theſe being thus finiſhed, ſet them to dry untill you have occaſion to uſe them: and then putting the open end in powder on the top of the Racket, in that place after the firſt paſtboard, or cover, is placed in a Racket; next the compoſition, where I taught you before to put powder for to make a report: which now you muſt leave out to place in theſe Stars; after this manner make two or three holes in that paſtboard, which prime with powder-duſt: and thereupon put a little Piſtoll powder, to blow the Stars out, when the Racket is ſpent; after the powder, put as I have ſaid before, the open ends of theſe Stars, down upon that powder: when you have put them ſo cloſe as they can ſtick one by the other, put a little ſmall corned powder on the top of them, to run between them, and put another tyre of Stars upon that, and in like manner a third tyre upon them, till you come to the top of the Racket-caſe, there put a paper over the head of it, and tye it cloſe about the top, that

none

none of the powder come from under or between the Stars.

How to prepare the Cotton-week, to prime the first sort of Stars.

Take Cotton-week, such as Chandlers use for candles, double it six or seaven times double, and wet it thoroughly in *Saltpeter*-water, or *Aquavitæ*, wherein some *Camphire* hath been dissolved, or for want of either in fair water, cut it in divers pieces, roul in mealed powder, dry it in the Sun, and it is done.

CHAP. 15.

How to make silver and golden Rain, and how to use them.

NOw I shew you the order of making golden Rain, which is after this manner: you must provide store of Goose-quils, which being provided, you must

must cut them off so long as they are hollow, the composition to fill these must be made thus; two ounces of cole-dust to one pound of powder well mixed; having filled many of these quils; you shall place them in the same place as I taught you to put the powder and Stars, first putting a small quantity of Pistol powder under them, to blow them out when the Racket is spent: upon this put your quils, as many as will fill the top of the case, with the open end downwards, so soon as the Racket is spent, you shall see appear a golden showre, which by some is called golden Rain, the like way you may make silver Rain; filling the quils with the composition for white Stars.

CHAP.

CHAP. 16.

How to make Fiſgigs, which ſome call by the name of Serpents, and to uſe them.

You muſt provide a ſmall rouling pin, about one quarter of an inch in thickneſſe, upon which roule ſeven or eight thicknesſes of paper: fill them four inches with powder duſt, ſometimes putting between the filling a little of the Compoſition for Rackets of 10 ounces: and at the end of four inches choak him, fill two inches more with Piſtoll powder; then choak the end up: at the other end put in a little of the mixture for Stars, and choak between that & the compoſition, & you have done: put divers of theſe, with the Starry end downwards, upon the head of a Racket, as you did the quils, with powder to blow them out, when the Racket is ſpent, they will firſt appear like ſe many Stars, when the Stars are ſpent, taking hold of the pow-

der

der duſt, they will run wrigling to and fro like Serpents; and when that Compoſition is ſpent, they will end with every one a report, which will give great content. I ſhall have occaſion to ſpeak of theſe Fiſgigs in other Fire-works.

CHAP. 17.

How to make Girondels, or (as ſome call them) Fire-wheels.

A Fire-Wheele, is often required in great works for pleaſure, and therefore I have thought fit and neceſſary, to ſet down their deſcription: as well as of all other ſorts of Fire-works; Firſt, you muſt make a wheele of Wood, ſo big as you pleaſe to make Girondels, and unto theſe bind Rackets very faſt of a mean bigneſſe, with the mouth of one towards the tayle of another, thus continuing untill you have filled your Wheele quite round; which done, cover them with paper paſted very curiouſly, that one taking fire, they may not take

take fire altogether; and daube Sope upon them quite round, leaving the mouth of one of them open to give fire thereto, for the first Racket having burned, will give fire to the next; keeping the Wheele in continuall motion, untill they be all spent: there may be bound fire Lances, to these Gerondels, either upright, or near, overthwart, which will make to appear diversity of fiery Circles; Your care must be, to place the Girondels at a convenient distance, from other Fire-Works: lest they should cause confusion, and spoile all your Work.

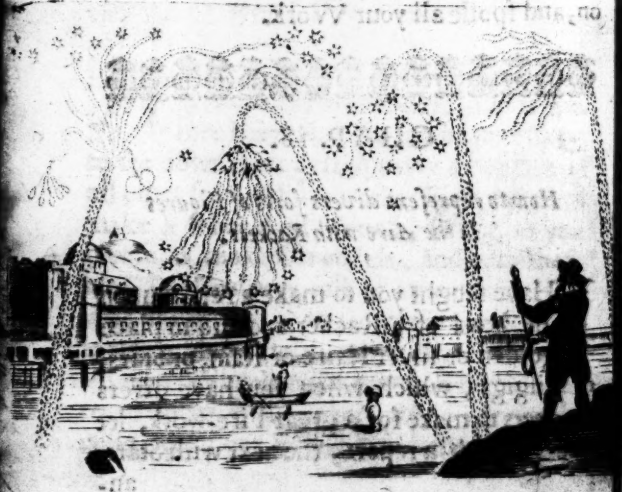
CHAP. 18.

How to represent divers sorts of Figures in the Aire with Rackets.

I Have taught you to make a report upon the head of a Racket, and also to place golden or silver Haire or Rain, or Stars, or Fisgigs, which when you have divers Rackets to make for a great Fire-work, let one be with a report, the next with Stars, an-

another with Gold Haire, or Rain, one with Silver Haire or Rain, for ſtanding juſt under the Racket it appeareth like Rain, but being aſide hand like Golden or ſilver Haire: and upon the head of another Racket place the Fiſgigs, which when the Racket is ſpent will firſt appear like ſo many Stars after they are ended, they will ſhew like Serpents wriggling to and fro; and laſtly, give every one his report.

To repreſent a Tree in the Ayre.



It is a rare thing to represent a Tree or Fountain, in the aire, which is made by putting many little Rackets upon on great one, passing all the rods of the little ones thorow wires, made on purpose upon the sides of the great one, or some other way, as your industry will discover; now if the little ones take fire while the great one is mounting up, they will represent a Tree, but if they take fire as the great one is descending or turning down again towards the ground, then they will be like a fountain of fire; if there be two or three little Rackets amongst others, that have no rods, they will make divers motions contrary to the rest, very pleasing.

If before you put the Fisgigs upon the head of a great Racket, you with a small string tye them together, a foot of line between, when they are on fire in the Ayre you will see very great variety of Figures, because as they wriggle to and fro, they will pull one another after them, to the speculatour a great deal of content: it will be pleasant if you tye them not all together but three or four, which will in the firing of them

them, be diſtinguiſhed from the reſt, with great variety.

CHAP. 19.

How to make Fire-lances.

THe uſe of theſe Lances is much required in all great Fire-Works, and I taught you before to uſe them in the Fire-Wheels; the manner of their making is thus, you muſt make Cartouches or caſes juſt like the caſes for Rackers: onely theſe for a need may be made of paſtboard, and glued as they are a rouling of them, if for great ones; but it is beſt to make little ones of paper, the caſe being provided, let them be filled with the dry compoſition for Stars; in the thirteenth Chapter of this Book: prime them with wet Gunpowder; the lower end of the caſe is ſtopped with a piece of wood, to the end they may be nailed, and ſtuck, when, and where, they ſhall

be used, the wood being about three fingers breadth long, out of the Cartouch.

CHAP. 20.

How to make a Racket, which firing it out of your hand, shall continually be in agitation, either on the earth, or in the aire.

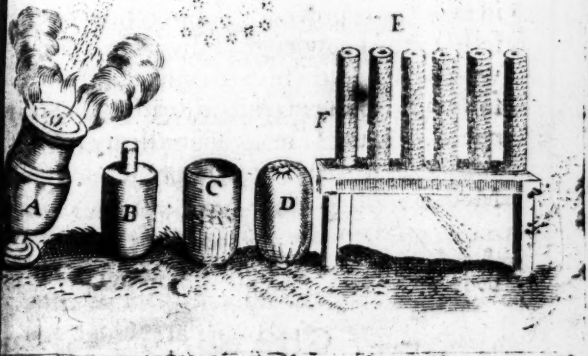
HAving prepared a Racket with a report in the head, such as I taught you first to make, tye it to a bladder, so that the end of the Racket may come to the mouth of the said bladder, and binde it over very strongly, then firing it out of your hand, cast it away from you, it matters not which way, so it wil come to the ground, there by reason of the bladder it cannot stay, but presently rebounds upwards, moving to and fro, untill all be spent: there is another sort, and that is a small Racket, put into a bladder, and so blown up round about it, and tyed about the neck thereof, which will have delightfull motions.

CHAP. 21.

The manner how to make Balloons for the Mortar-peece.

FIrſt, you muſt provide a wooden rowler, twice ſo long as in diameter, you muſt have it of ſuch bigneſſe as you deſire to make the inſide of your Balloon, upon which rouler let there be rouled ſo many paſtebords as you ſhall think ſufficient for ſtrength, being well glued together; then choak this Cartouch at the one end, leaving a little hole for a port-fire, as ſhall follow, and glue it in, this port-fire ſhall be made juſt like a Racket, of the bigneſſe of the hole you leave open for it, and filled with compoſition for Rackets of that ſize, not pricking it with a bodkin, as you are taught to prick other Rackets, and to know of what length the port-fire ought to be, it will not be amiſſe to try one Balloon filled with earth, and your port-fire faſtned there-

unto



unto: Now to fill the Balloon, place all your Serpents within it, together with Stars, Rackets and Crackers, in such a convenient manner that there may be very little void room, within the Cartouch: it being thus filled, put in as much powder dust as you can, that it may run every where thorow the chinks, between the Serpents, Rackets, and Stars, that they may all fire; and that the said powder dust may break the Balloon: these

things being thus disposed choak up the other end close, and charge it in the mortar, as I have taught you to do the canvas Granado; and you may shoot it when you please.

Such Balloons I have at this present, and doe assure the Reader, that this description is in every part proved, and practised by my self; to the knowledge of divers spectators, who have seen these experimented: I do also signifie to the ingenious Reader, that it is not good to use so many ingredients (in Fire-works) as the Ancient, nor so few as some Modern.

CHAP. 22.

A most precious Unguent for any burning.

BEcause that divers men in their practising Fire-works, one time or other chance to be burned by them, and also by the blowing up of Gunpowder many are burned in the face, or elswhere; I will shew you such salves which I have cured my self withall, I having them out of Master

ſter *Malthus* his Fire-works, and experimented them upon my ſelf to my great good when I was burned.

The Unguent.

TAke freſh Hogs-greaſe or Lard, as much as you pleaſe, and boyl it taking off the skum until there ariſe no more skum, then ſet the Lard three or four nights abroad; after which it muſt be waſhed in running water, to take away the ſaltiſh nature; and alſo to cleanſe it white; then melt it, and keep it for your uſe.

Otherwiſe.

THe white of an Egg, and freſh butter being mingled together, and well beaten into an ointment, is excellent.

Ano-

Another ſort moſt excellent.

TAke a ſtone of quick-Lime, and let it diſſolve in clear water, and when the water is ſetled, pour it gently out from the Lime, thorow a linnen cloth, then put as much ſallet oyl (as you take water) together, and beating it all to an oyl, you ſhall have a moſt excellent Unguent for all manner of burning.

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